Uranium Mining in Canada and Australia: The Impact of Taxation

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Foreword

Nuclear energy, and the uranium industry along with it, have faced powerful public opposition in recent decades. Projections for growth in this sector have proven far too optimistic, as more and more countries have slowed and even reversed their dependence on nuclear energy. However, new economic, environmental, and health and safety concerns are emerging that are turning the tide back towards uranium-based energy systems. Hydrocarbon-based fuels are associated with air and water pollution and global warming, and the growing number of serious oil spills shows that even the transportation of some raw materials to market can carry a heavy environmental cost. Furthermore, new cost-efficient energy technologies and alternative energy sources have not been developed as quickly or as easily as originally foreseen.

One consequence of these new developments and understanding is a renewed interest in uranium mining. This study looks at the world's two leading uranium exporters, Canada and Australia, and offers useful insights on the implications of their tax regimes for the competitive position of uranium mining. The impact of the six tax regimes studied (in three provinces in Canada and three states in Australia) is found to be both high and variable, changing as a function of deposit type and location. The findings provide useful information, both for those in charge of planning exploration programs and new mine developments, and for those responsible for tax regimes in regions, wherever located, with good potential for uranium mining.

Although the publication date for this work is August 1991, the writing and review stages were completed in January 1991, before the March 3 announcement by Denison Mines that it is closing its Elliot Lake uranium mining operations, so this major event is not reported in the text.

The views expressed are those of the authors and do not necessarily represent those of the Centre for Resource Studies or its sponsors or the Electricity Branch of Energy, Mines and Resources Canada.

Margot J. Wojciechowski
Executive Director

Executive Summary

Canada and Australia are major players in the world's uranium industry and principal competitors for the uranium export market. The objective of the study is to compare the impact of taxation on the economic viability and competitive position of uranium mining in the two countries.

The evaluation is based on four types of uranium deposit which are of primary economic interest in Canada and Australia. Four hypothetical project models were designed for evaluation, based on these deposit types. The deposits are assumed to have been discovered and delineated, and are awaiting a mine development decision. Uranium mining project profiles have been constructed for the four cases, synthesized from actual situations in order to provide realistic development scenarios.

The base case conditions, which are used as a standard of comparison with other results, include an "expected" uranium price of US$30 per pound of U_3O_8 and a 10-percent cost of capital. Market price and cost of capital are considered as the two principal variants for sensitivity analysis.

To be most suitable for tax analysis, the project models have been designed to give a good economic spread of before-tax returns, varying under base case conditions from marginally economic to highly profitable. In order to achieve the desired make-up, the projects tend to portray superior examples of the respective deposit types in terms of ore reserves and costs.

By normal mining standards, the uranium projects are relatively large. Before-tax evaluation results under base case conditions vary as follows among the four cases:

- total sales revenue ranges from $2.0 billion to $12.8 billion;[1]
- rate of return (as defined on page 40) varies from 14 percent to 45 percent;
- net present value at 10 percent ranges from $151 million to $1,817 million.

The uranium project models, initially appraised on a before-tax basis, are then subjected to taxation. The following six taxation jurisdictions, three in Canada and three in Australia, are selected for primary attention on the basis

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[1] Money values are expressed throughout in constant 1990 Canadian dollars, unless otherwise noted.

of representing geologically prospective environments for the types of deposit being evaluated:

- Ontario;
- Northwest Territories;
- Saskatchewan;

- Northern Territory;
- South Australia;
- Western Australia.

Several taxation criteria are assessed in each case, including after-tax measures of investment incentive, discounted tax revenues, effective tax rates, intergovernmental tax shares, and comparative tax levels.

The impact of taxation is shown to be both high and variable. Also, the ranking of the six tax jurisdictions changes somewhat as a function of the deposit type, market price, and cost of capital variants. Of course, use of the four project models for comparisons of taxation effects in the six selected jurisdictions does not necessarily reflect the impact of tax on actual investment opportunities.

Generally speaking, the taxation systems in Saskatchewan and Australia's Northern Territory generate the most government revenue and provide the lowest incentive for investment. At the other end of the spectrum, the Northwest Territories and Ontario offer the best investment incentive and collect the least amount of taxes. South Australia and Western Australia tend to be positioned between these extremes. For example, effective tax rates range as follows for expected study conditions:

- 43-51 percent in the Northwest Territories;
- 48-59 percent in Ontario;
- 50-64 percent in Western Australia;
- 52-64 percent in South Australia;
- 52-70 percent in the Northern Territory;
- 68-71 percent in Saskatchewan.

The competitive tax positions of Saskatchewan and the Northern Territory are not surprising. Relatively profitable "unconformity-related" type uranium deposits have been discovered and developed in these jurisdictions. Their taxation systems have obviously been designed accordingly.

The Saskatchewan uranium royalty system is shown to be the only "progressive" regime evaluated, capturing an increasing proportion of before-

tax net present value as project profitability rises. Conversely, the Saskatchewan system is found to provide for more incentive at the investment margin. This illustrates a competitive advantage associated with the progressive tax structure which is of particular importance in the context of the current situation of depressed uranium price.

All of the other taxation systems analyzed are "regressive", the burden of taxation being greatest at the investment margin, and then decreasing as a function of profitability. Revenue-based taxation, a prominent feature of the Northern Territory and Western Australia regimes, has particularly distorting effects on investment.

At this point, it should be stressed that the study focuses exclusively upon the effects of taxation. Tax is undoubtedly one important determinant of economic viability and competitive position. Nevertheless, the taxation component should be put in context. In this respect, it is important to note that the study does not consider differences among the jurisdictions examined in terms of geological potential, economic conditions, and other aspects of government policy.

The project evaluation results highlight a number of circumstances under which the uranium projects would be uneconomic to develop. As price and cost of capital are varied on a before-tax basis, several situations are found to be uneconomic. Additional potentially economic circumstances are rendered uneconomic as the result of inefficient taxation policies. To the extent that taxation acts in this way, the actual value to be realized from the projects falls short of the potential value which exists. The wealth-creating, employment, income, and foreign exchange benefits associated with uranium mining are thereby diminished.

This brings us to an important concluding point of mutual interest to Australia and Canada. The projected market price conditions used in the evaluation are significantly above present-day spot prices, and would be viewed by some as being on the optimistic side of longer-term expectations. Also, the four project models which are used as "measuring sticks" comprise superior ore reserve and cost characteristics in order to give a good economic range of before-tax returns. Even so, as price and cost of capital are varied, and the evaluations proceed from a before-tax to an after-tax basis, a large number of project situations become uneconomic. Thus, the study demonstrates quite clearly that only the very best uranium mining projects have a chance of being developed under current market conditions, and even these can be rendered uneconomic by excessive taxation regimes. It follows that exceptionally good-quality targets will have to be identified to provide the economic justification for uranium exploration. These realities will likely restrict uranium exploration and development activities for some time, not an unexpected response to a market situation where low prices have been caused largely by excess supply.

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1. Introduction

Study Objective

The objective of this study is to examine the impact of taxation on the economic viability and competitive position of uranium mining in Canada and Australia.

Setting

The economic potential of mining can be assessed in a number of ways. One approach, increasingly being used for both corporate planning and government policy purposes, is to evaluate the competitive position of an actual or potential mineral producer in the international marketplace relative to other suppliers.

Australia is Canada's principal competitor in the uranium export market. As the western world's third-largest uranium producer after Canada and the United States, 100 percent of its production is exported to markets in western Europe, the United States and Japan, in direct competition with Canadian producers. Australia ranks first in terms of "known" uranium resources of current economic interest, with about 30 percent of the western world's total. Several significant deposits remain undeveloped because of the Australian government's current restrictions on new uranium mine developments.

The potential for additional uranium discoveries in Australia is excellent, perhaps even exceeding that of Canada. The two countries have similar geological environments, which are among the most promising in the world for uranium exploration. The uranium provinces of Canada's Athabasca Basin and Australia's Northern Territory are directly analogous.

There are a number of additional similarities between Canada and Australia that support the decision to use them for comparative purposes in the present study. The two countries have much the same constitutional histories and political relationships between their federal/commonwealth and provincial/state levels of government. Also, the infrastructural problems

associated with the development of mining projects in remote areas are comparable.

The mining taxation systems which exist in Canada and Australia are complex. Rules vary not only between the two countries, but also among the constituent provinces and states. It is not uncommon for provinces and states to provide special treatment for specific types of mining (uranium mining in Saskatchewan, for example), and even, occasionally, individual projects (as is the case for the Olympic Dam mine in South Australia).

Variations in tax policy have a direct effect on the economic viability of uranium mining. This study examines the impact of taxation on both project viability and competitive position among several Canadian and Australian jurisdictions.

Scope

The evaluation centres on four uranium mine development models which are used as "measuring sticks". Uranium deposits of the four types chosen for study purposes either are known to occur or can be expected to be discovered in both Canada and Australia.

These uranium mining projects are initially appraised on a potential-value or before-tax basis. Then, the projects are evaluated after tax in several provinces, states, and territories. A number of economic indicators and taxation criteria are assessed and compared in each case.

The study focuses exclusively upon the taxation component of competitive position. The effects of corporate income taxes, and mining taxes and royalties are analyzed. Other types of "non-profit" taxes are not considered. More generally, no account is taken of differences in geological potential, econo.nic conditions, and other aspects of government policy, among the jurisdictions examined.

Organization of the Report

The outline of the report is as follows. An executive summary of findings is presented at the outset. In Chapter 2, the Canadian and Australian uranium industries are briefly placed into the world context, as background to the study. Chapter 3 delineates the study in terms of the general economic conditions adopted, the representative uranium projects analyzed, and the taxation regimes examined. The evaluation procedure applied is described in Chapter 4, including a brief review of the economic indicators and taxation criteria appraised. Before-tax and after-tax findings for the uranium project

evaluations are presented in Chapters 5 and 6, respectively. Chapter 7 compares the government revenues which would result from taxing the projects in the various jurisdictions. The effective tax rates associated with these payments are discussed in Chapter 8. The division of total tax revenues between levels of government and types of tax is examined in Chapter 9. Chapter 10 looks at comparative tax levels among the Canadian and Australian jurisdictions, and considers their implications for competitive position. The final chapter then reviews the main findings and draws an important conclusion.

Several matters summarized in the text are described in greater detail in the appendices. Appendix I provides profiles of the uranium project models. The Canadian and Australian taxation systems applied are defined in Appendices II and III, respectively. A full set of study results, the basis for the findings presented in Chapters 5 to 10, are tabled in Appendices IV to IX, respectively.

2. Australian and Canadian Uranium Industries

Overview

Canada and Australia are both major players in the world's uranium industry. Canada is the largest producer and exporter of uranium in the Western world, with recent annual output in the order of 11,000 metric tons (t) of uranium (U),[2] accounting for about 33 percent of total output. Australia ranks third, behind the United States, with about 11 percent of recent Western world output, as illustrated in Figure 1. About 85 percent of Canada's uranium output is exported, while Australia exports its entire production. Uranium production occurs in just two Canadian provinces, namely Ontario in central Canada, and Saskatchewan in western Canada; similarly in Australia, production comes from two states, the Northern Territory and South Australia.

Australia ranks first in terms of known (discovered) lower-cost uranium resources, while Canada comes fourth, behind Niger and South Africa (see Figure 2). Over half of Canada's resources in this category occur in unconformity-related type deposits,[3] primarily in northern Saskatchewan, while much of the remainder occurs in quartz-pebble conglomerates, primarily in the Elliot Lake area of Ontario. A large proportion of Australia's known lower-cost resources also occurs in unconformity-related type deposits in the Alligator Rivers area of the Northern Territory, although substantial resources occur in the Olympic Dam orebody, a breccia-complex deposit in South Australia, where uranium is found in association with copper and gold. Other settings in Australia host calcrete-type deposits, sandstone deposits, and vein-type deposits. Beyond these discovered tonnages, there is considerable potential for the discovery of additional uranium resources in both countries. In fact, estimates of this potential exceed 1 million t U in both Canada and Australia.

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[2] Metric units are used in all tabulations. Resources and production quantities are expressed in terms of metric tons (tonnes) contained uranium (U) rather than uranium oxide (U_3O_8).

1 short ton U_3O_8 = 0.769 tonnes U

\$1/lb U_3O_8 = \$2.6/kg U.

[3] Table 1 describes the deposit types discussed in this paper.

Figure 1. Western world uranium production, 1989
Source: NEA/IAEA "Red Book", Paris, 1990.

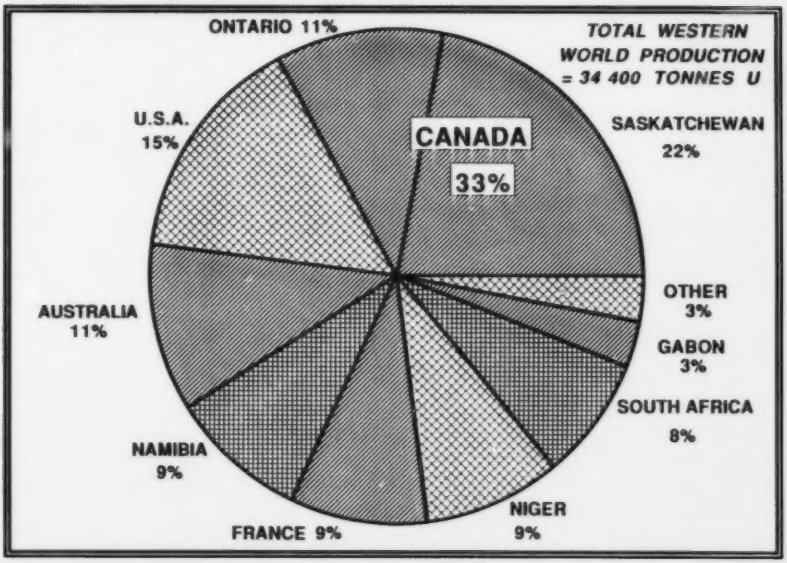


Figure 2. Estimates of known uranium resources in selected countries
Source: NEA/IAEA "Red Book", Paris, 1990.

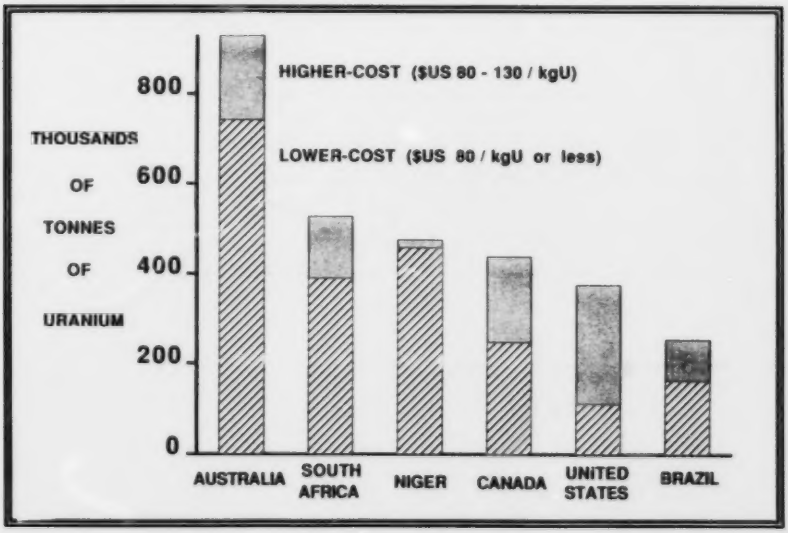


Table 1. Geologic setting of important uranium deposits

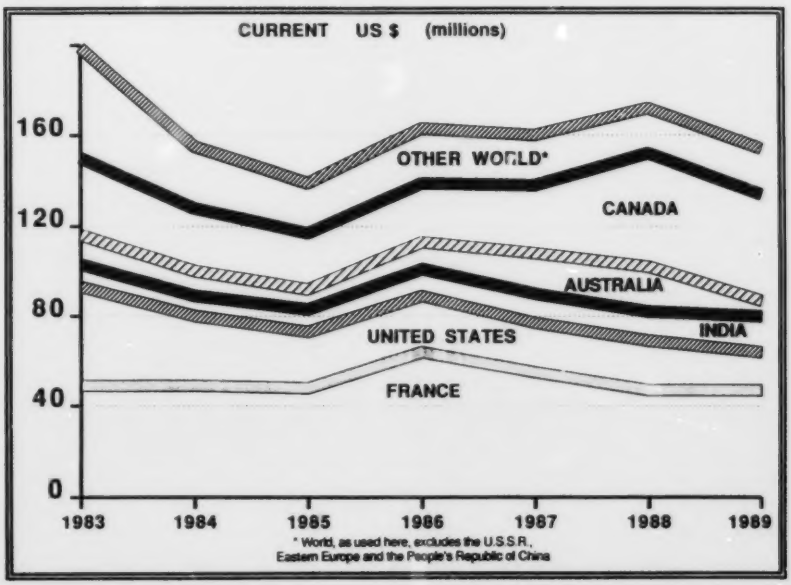
Deposit Type	Major Distinguishing Features	Locations
Unconformity related	Formed spatially close to ancient surfaces of major erosion or non-deposition, i.e. at an unconformity; most were deposited between 1,600 and 800 million years ago.	In the Athabasca Basin, Saskatchewan, and the Pine Creek Geosyncline, Northern Territory
Quartz-pebble conglomerate	Formation restricted to one specific period of geologic time; cemented, water-worn siliceous pebbles deposited unconformably above the older granitic and metamorphic rocks.	At Elliot Lake, Ontario, in the Witwatersrand, South Africa, and occurrences in the Northern Territory, and in Brazil and India
Breccia-complex	Formed between periods of tectonic activity, above granitoid basement rocks, with two phases of mineralization; deposited within volcaniclastic and sedimentary rocks.	Archetype is Olympic Dam deposit (at Roxby Downs), South Australia
Sandstone	Mineralization in continental sandstones, mostly in medium- to coarse-grained, poorly cemented sands.	In the western United States, and in France, Niger, and Gabon
Vein	Formed as mineralization fills faults, cracks or fissures in the host rock; deposits range in size from a few massive veins to contiguous networks of veinlets.	In Czechoslovakia, Zaire, Canada and Australia
Surficial	Formed relatively recently, predominately as surface sediments, perhaps deeply buried and/or calcified; includes bog deposition.	In Australia, Namibia, Somalia and Canada

Source: Adapted from NEA/IAEA definitions of Geological Setting of Uranium Deposits (Ref. NEA/IAEA, 1990).

With its sizeable share of the world's known uranium resources, Canada remains the focus of international uranium exploration activity (see Figure 3). Expenditures for uranium exploration in Canada approached US$50 million in both 1988 and 1989. The Athabasca Basin in northern Saskatchewan remains the principal target for discovering very high-grade, low-cost uranium deposits. In 1990, for example, Cameco Corporation indicated that its most-recently announced discovery, the P2 deposit at the McArthur River project in Saskatchewan, contains an estimated 77,000t U, with grades up to 65 percent U but averaging over 3 percent U.

Considering Australia's vast endowment of discovered uranium resources, exploration activity has been less than might be expected, no doubt due to current Australian government policy which does not permit the development of new uranium mines beyond the three existing operations. The last major uranium discovery announced was the Kintyre deposit in Western Australia; this unconformity-related type deposit is estimated by CRA Limited to contain a total of 30,000t U with ore grades averaging between 0.13 and 0.34 percent U. In 1988, uranium exploration expenditures reached US$21 million, less than half that of Canada.

Figure 3. Uranium exploration expenditures in selected countries, 1983-89
Source: NEA/IAEA "Red Book", Paris, 1990.



The Canadian Industry

Production of uranium ranks sixth among Canada's top ten non-fuel minerals,[4] with an annual value approaching C$1 billion.[5] As the domestic market requires only about 15 percent of current Canadian production, the remaining uranium produced in Canada is exported for nuclear electricity generation abroad. Canada has three important export markets: the United States, East Asia and Western Europe, each taking a significant share of Canada's exports. In recent years, uranium exports have varied from 8,000 to 12,000t U annually, depending on the contract mix. At the end of 1990, fewer than 2,800 workers were directly employed in Canada's uranium production facilities.

In 1990, Canada's primary uranium operators were Denison Mines Limited, Rio Algom Limited, Cluff Mining, and Cameco Corporation. In Ontario, production comes exclusively from underground mines, whereas in Saskatchewan production comes from several open-pits and an underground operation. Total output in 1989 approached 11,400t U, while uranium shipments reached 11,000t U; the difference between output and shipments went to inventory. Two-thirds of Canada's uranium output and shipments come from Saskatchewan, with the balance coming from Ontario.

In Ontario, Rio Algom and Denison produce uranium from a fairly uniform, low-grade, quartz-pebble conglomerate deposit, with grades averaging between 0.05 and 0.1 percent U; both operate highly mechanized and efficient, large-tonnage underground mines. With the closure by Rio Algom of two of its three Elliot Lake operations in mid-1990, each company produces from a single production centre. Both companies have been operating at Elliot Lake since the late 1950s and have established records as reliable long-term suppliers, supported by large reserves. At the end of 1990, the two companies directly employed about 1,600 persons and indirectly supported the major portion of the population of Elliot Lake, which approached 15,000.

By world standards, both Rio Algom and Denison are relatively high-cost uranium producers, particularly compared to uranium producers in Saskatchewan. They have been surviving in recent years because of the existence of long-term contracts negotiated in the 1970s when uranium prices were much higher than today and were projected to continue to increase. Although both producers have been successful in containing production costs and increasing productivity, they are unable to compete in the current export market.

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[4] For statistical purposes uranium is included with the production of metals.

[5] "Annual value" as used here is the value of "shipments" which can be equated roughly to sales.

Ontario Hydro, Canada's major nuclear utility, has been relying on Denison and Rio Algom for about two thirds of its uranium requirements, under long-term contracts scheduled for completion early in the next century. At year-end 1990, Rio Algom's remaining Elliot Lake operation continued to produce as a dedicated supplier to Ontario Hydro and, with the end of its export contract in sight, Denison adjusted to the reality of a single domestic customer. In early 1991, negotiations were underway with both companies to determine if the contracts would continue beyond the early 1990s and, if so, under what terms and conditions.

Denison hopes to develop its high-grade Midwest joint-venture uranium project in northern Saskatchewan for production in the mid-1990s, and has recently acquired joint-venture uranium by-product operations in Louisiana. It also holds the Koongarra uranium project in Australia's Northern Territory, development of which is not permitted currently under Australia's three-mine policy. Similarly, Rio Algom has a number of other uranium production options, having acquired several uranium properties in the United States in the last year or so.

The Saskatchewan uranium mining industry is centred in the north of the province, essentially around the rim of the Athabasca Basin. There are currently only three producing operations in the province, at Key Lake, Rabbit Lake/Collins Bay and Cluff Lake, and these account for two thirds of Canada's uranium output. Two operating companies, Cameco and Amok Ltd, manage these three modern, low-cost production centres, which exploit relatively high-grade unconformity-related deposits. Average grades in deposits of this type can vary from below 1 percent U to over 10 percent U. The mines are particularly cost-competitive in view of these high grades and the use of less labour-intensive mining methods (open-pit, predominantly).

The major shareholder in Saskatchewan's uranium industry is Cameco. In mid-1990, it sold to Uranerz Exploration and Mining Limited a one-third interest in the Rabbit Lake/Collins Bay/ Eagle Point properties, as well as a one-third interest in the Rabbit Lake mill. Cameco and Uranerz now have identical equity splits (2/3 and 1/3, respectively) in both the Key Lake and Rabbit Lake operations. The other major owner in Saskatchewan's uranium industry is Amok Ltd, which holds 80 percent in the Cluff Mining partnership. Cameco holds the remaining 20 percent.

With its share of the three Saskatchewan operations, Cameco accounts for about half of Canada's uranium production, and is the largest uranium producer in the world with almost 15 percent of global production. Cameco also controls a large portion of Canada's known uranium resources of current economic interest.

Cameco's Rabbit Lake mill, shut down in 1989 due to the weak market, remained closed at year-end 1990. Mill circuits have been upgraded, and capacity expanded to 4,600t U per year, to handle ore from Cameco's nearby

Eagle Point deposit when required. At Eagle Point, site preparation is well underway, with work focused on construction of a decline in preparation for scheduled production in 1993. At Cluff Lake, production from the new Dominique-Janine North open pit began in 1990, following ore depletion at the Claude open pit.

The existing uranium-producing industry is largely Canadian-owned. Denison Mines Limited and Cameco Corporation are Canadian companies. Cameco, jointly owned by the Saskatchewan and Canadian governments (62 and 38 percent, respectively) is to be privatized on a phased basis over the next few years. Uranerz Exploration and Mining Limited is the Canadian subsidiary of Uranerzbergbau mbH of the Federal Republic of Germany, Amok is 75 percent owned by Compagnie Générale des Matières Nucléaires (COGEMA) of France, and Rio Algom is 53 percent held by RTZ Corporation of the United Kingdom.

Foreign participation in uranium exploration in Canada has been high throughout the 1970s and 1980s. Currently, foreign companies account for about two thirds of Canada's total uranium exploration expenditures, compared to just over half in 1981. Participation by US firms has steadily decreased since 1984, and in recent years has represented less than 2 percent of total expenditures. The principal foreign participants are British, French, German and Japanese companies, which are seeking secure, long-term sources of uranium supply for their national nuclear power programs.

The Australian Industry

Australia is the western world's third-largest producer of uranium after Canada and the United States, and ranks second in terms of exports (the U.S. exports very little). Currently, two producing operations have a total annual output of about 3,600t U; a third licensed property is held on a care-and-maintenance basis. The Australian government's present uranium mining policy provides for the production and export of uranium from only these three existing operations, namely, Ranger and Nabarlek in the Northern Territory and Olympic Dam in South Australia.

As is the case for Canada, all Australian uranium is used for peaceful purposes, i.e. to generate electricity. As there is no domestic nuclear power industry, all Australian production of uranium is destined for the export market. The value of Australian uranium exports is estimated at roughly A$300 million annually. Australian producers compete head-on with their Canadian counterparts in the three main market areas of Western Europe, the United States, and East Asia. Currently, some 1,000 workers are directly employed at Australian uranium production facilities.

In 1990, Australia's two primary uranium producers were Energy Resources of Australia (ERA) in the Northern Territory and the Olympic Dam Joint Venture in South Australia. ERA's Ranger mine is an open pit, whereas Olympic Dam is an underground mine. Although Australian output in 1989 was only 3,600t U, production capacity approaches 5,000t U. The fact that the two producers could expand their combined capacity to 8,500t U per year, given appropriate market incentives, underscores Australia's potential as a future uranium supplier.

In the Northern Territory's Alligator Rivers area, Queensland Mines Limited depleted its Nabarlek deposit by open-cut mining during 1979; ore grades at this unconformity-related type deposit averaged around 1.6 percent U. The ore was stockpiled and processed on site until mid-1988, at which time production ended. The mill is currently held on a care-and-maintenance basis. Exploration is continuing under existing licences in areas adjacent to the Nabarlek lease, with the hope of delineating another orebody.

The bulk of Australia's uranium production since 1982 has come from ERA's modern, low-cost, conventional open pit Ranger operation; ore grades at the unconformity-related type deposit average just over 0.2 percent U. The project area, part of a land title given to the traditional Aboriginal owners, is encircled by, but excluded from, the Kakadu National Park. It follows that the mine is one of the most environmentally regulated in the world. With current nominal output capacity of 3,200t U per year, ERA has an agreement with the government entitling it to increase plant capacity to 5,100t U per year if and when it is commercially practicable. ERA has undertaken measures to improve operating efficiencies and cut costs at Ranger, and has reportedly examined the possibility of acquiring mining assets in the United States and Canada.

In central South Australia, the Olympic Dam deposit is one of the world's largest polymetallic mineral concentrations. At this unique breccia-complex deposit, where uranium is found in association with copper and gold, ore grades average 0.05 per cent U, 1.6 percent Cu and 0.6 grams Au per tonne. The modern, highly mechanized, underground mining operation produces over 4,000t of ore per day. The facility includes a concentrator, hydrometallurgical plant, copper smelter, and copper refinery, where high-quality copper, gold and silver are final products. Uranium production began in 1988 and reached 850t U in 1989, although nominal annual output capacity, currently at 1,600t U, could be expanded to 3,400t U, depending on the markets.

As in Canada, Australia's uranium-producing industry is largely domestically owned. The Nabarlek operation is held by Queensland Mines Limited, a subsidiary of Pioneer International Ltd, an Australian company. The Ranger project is owned by ERA, a majority Australian-owned consortium whose principal shareholder is North Broken Hill Peko Limited, with about 65 percent. The Olympic Dam Joint Venture is majority Australian-owned by

Western Mining Corporation Limited, with 51 percent of the project; BP Australia Limited holds the remaining interest.

As in Canada, a number of foreign companies have been actively exploring for uranium in Australia. They tend to be the same companies which are active in Canada, primarily British, French, German and Japanese, many of which are linked either directly or indirectly to state nuclear fuel procurement programs. An increase in foreign participation can be expected should current restrictions on the development of new uranium mines in Australia be removed.

Uranium Policies

Canada and Australia have similar constitutional histories and political relationships between their federal/commonwealth and provincial/state levels of governments. In both cases, overall jurisdiction of the uranium industry rests with the senior level of government. As two of the Western world's principal uranium producers and exporters, each has developed a number of uranium-specific policies to meet government objectives. While some policy elements are distinctly different, others are very similar, particularly in the area of uranium exports.

In Canada, the only federal government policy that has a direct impact on uranium development, and thus has relevance to this study, is a policy on non-resident ownership in the uranium mining sector. However, a new issue, the federal environmental assessment and review process (EARP) may also have implications for the future. In Australia, the commonwealth government policy of most relevance to this study is that which currently restricts production and export to only three named mines. These policies, together with the export policies of both countries, are reviewed briefly as follows.

Canadian Uranium Policies[6]

Foreign Ownership Policy

In Canada, there are no restrictions on foreign investment at the exploration stage. However, certain conditions must be met by the stage of first production. In late 1987, a new policy on non-resident ownership in the uranium mining sector was announced to replace the existing one, which had been first

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[6] Ref: Smith and Williams, 1990

put in place in 1970. The new policy is designed to promote economic development, exports and jobs for Canadians by encouraging investment in Canada's uranium mining industry. It provides considerably more flexibility to investors, both Canadian and foreign, than did the previous policy, and should facilitate the efforts of those interested in financing the development of recent Canadian uranium discoveries.

The primary policy objective is a 51 percent level of resident ownership in individual uranium-producing properties, at the stage of first production. However, lower levels of resident ownership would be permitted if it can be clearly established that the project is in fact Canadian-controlled, as defined in the Investment Canada Act. Only in cases where it can be demonstrated clearly that Canadian partners cannot be found will exemptions to the policy be granted, subject to Cabinet approval.

Environmental Assessment and Review

On June 18, 1990, Canada's Minister of the Environment announced a major package of reforms to the federal government's environmental assessment and review process (EARP). A key feature of the reform package will be the proposed Canadian Environmental Assessment Act. The Act will formalize the federal government's obligation to integrate environmental considerations into the project planning and implementation process, and create a new agency to be known as the Canadian Environmental Assessment Agency.

The new Act will cover all projects for which the federal government holds decision-making authority – as a proponent, land manager, provider of funding or regulatory authority. Since uranium mining projects are licensed by the federal Atomic Energy Control Board (AECB), all new uranium producing projects will be subject to the new process. The process will inevitably have an impact on the lead times and related costs of new uranium projects.

Export Policy

There is an overriding policy objective, first enunciated as a component of uranium export policy in 1965, that Canadian uranium shall be used only for peaceful purposes. Since then, two significant steps have been taken to strengthen this objective. First, in 1974, it was stipulated that Canadian uranium shall not be used in connection with the production of a nuclear explosive device. Second, in 1976, it was announced that exports would be authorized only to those non-nuclear weapon states that have made a general commitment to non-proliferation by either having ratified the Nuclear Non-

Proliferation Treaty (NPT) or having taken an equivalent binding step and that have thereby accepted International Atomic Energy Agency (IAEA) safeguards on the full scope of their nuclear activities.

In the case of non-nuclear and nuclear weapons states alike, Canada seeks, in addition to a bilateral nuclear cooperation agreement on the peaceful non-explosive uses of nuclear energy, assurances with respect to the provision of fallback safeguards, the retransfer of Canadian uranium, controls over the reprocessing of Canadian-origin spent fuel and the subsequent storage of the separated plutonium, the enrichment of Canadian-origin uranium beyond 20 percent U-235, and adequate physical protection measures.

The commercial aspects of Canada's uranium export policy have evolved over the years with the primary objective of maintaining Canada's role as a reliable and competitive long-term supplier to its trading partners, while seeking to obtain optimum benefit for Canada from the development of its uranium resources. Elements of the uranium export policy are in place that seek to ensure adequate supplies of uranium for domestic needs, provide fair returns to Canadians from uranium exports, and realize opportunities for further processing (upgrading) of Canadian uranium prior to export.

With respect to prices, the Canadian government expects pricing terms in export contracts to provide for an equitable balance of benefits and risks, and to be generally not less favourable than those being obtained in the same time period by competing Canadian and international producers for contracts of similar duration. In the interests of promoting stable productivity and employment, each export contract should include mechanisms, such as escalating floor price provisions, which will help to reduce the impact of unexpected shifts in the market, and thereby contribute to a more predictable commercial environment for both the company and its employees.

As an objective, the further processing of Canadian uranium prior to export can be traced back to uranium policy statements in 1958 and 1969. It became a policy requirement in 1974, subject to the granting of exemptions in certain circumstances. In early 1990, the requirement was simplified and restated following a review of the commercial components of Canada's uranium export policy in the context of the Canada/U.S. Free Trade Agreement. Simply stated, all Canadian uranium destined for use as enriched fuel shall be upgraded to the maximum extent possible in Canada before export, as long as Canada's conversion facilities (operated by Cameco Corporation) have the capacity. However, exemptions to this requirement will be granted in cases where i) the uranium will be converted or enriched or consumed in the United States; or ii) the Canadian converter is not the successful bidder for the conversion services as a result of purely commercial considerations.

All uranium export contracts are reviewed to ensure that they are consistent with policy prior to application to the regulatory authority for the necessary export licence and export permit, in accordance with the provisions of the

Atomic Energy Control Act and the Export and Import Control Act, respectively. The uranium export contract review process is straightforward and efficient, and the related policies are applied in a realistic and pragmatic manner.

Australian Uranium Policies [7]

Three-Mine Policy

After the election of Australia's Labour Government in 1983, it was announced that exports of uranium from Ranger and Nabarlek would be permitted to continue, and that uranium mining would be allowed from the Olympic Dam project in conjunction with the mining of other minerals. The new government also announced a major inquiry into Australia's role in the nuclear fuel cycle. As a result of this inquiry, the government accepted "that exports of Australian uranium should not be limited as a matter of principle, but should be permitted subject to stringent conditions of supply designed to strengthen the non-proliferation regime". In deciding that Australia could make the most responsible contribution to the peaceful uses of nuclear energy by permitting the export of uranium in a strictly regulated manner, the government chose to maintain its "three-mine policy".

The policy was never intended to mean that any three mines could operate, but rather to specifically name Ranger, Nabarlek and Olympic Dam. Although production at Nabarlek has since been completed, the policy does not necessarily provide for additional developments to replace this operation. A reconsideration of this element of Australian policy is not likely until the completion of a Labour Party review of all aspects of uranium policy, the results of which are expected to be tabled for discussion at the next party conference in mid-1991.

Export Policy

Australia's nuclear safeguards policy, announced in 1977, is very similar to that adopted by Canada since 1974. It requires the customer country, if a non-nuclear weapon state, to be a party to the NPT, to conduct its nuclear activities under IAEA safeguards as required by the treaty, and to conclude a bilateral safeguards agreement with Australia. The bilateral agreement provides for assurance on the peaceful, non-explosive use of the supplied

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[7] Ref: Crick, 1990

uranium and nuclear material derived from it; supplied nuclear material to be subject to IAEA safeguards in the recipient country; fall-back safeguards, in case IAEA safeguards under the NPT cease to apply; the need to obtain prior consent for retransfers, enrichment beyond 20 percent, and reprocessing of the supplied material; and adequate physical protection for the supplied material.

As part of its export control over uranium, the Australian government has prescribed pricing standards in uranium contracts. Reflecting the concern that Australia should receive fair and reasonable returns for the production and export of its community-owned resources, uranium contract pricing became a key element of government policy. Since 1978, commercial policy meant specified floor price requirements for long-term uranium contracts, in order to provide a basis for project financing and world market stability.

In light of the international market realities in the late 1980s, the government re-examined its uranium contract pricing policy. As a result of this review, which took place in the context of renegotiations of contracts between an Australian producer and several of its customers, it was announced in September 1989 that the contract pricing policy no longer had a predetermined or fixed floor price. The government now examines contract pricing provisions and considers the prevailing market trends. Producers must show that the concluded contract prices are comparable with those being received by others in the market. If the price is considered fair and reasonable, and would provide an appropriate return for the community-owned resource, it would meet the government's new pricing policy.

Under the Australian government's uranium export policy, introduced in June 1978, a uranium producer was required to obtain a Ministerial "determination" before entering into sales contract negotiations. The determination specified the appropriate terms and conditions relating to contract duration, uranium quantities sold, method of shipment, price payable, manner of payment, and proposed use of the uranium. It also specified that a sales contract was required to contain appropriate terms and conditions consistent with Australia's nuclear safeguards policy. Contracts also needed Ministerial approval, which formed the basis for approvals to export the uranium covered by the contract. Furthermore, the determination required Ministerial certification that the uranium was produced from an approved mine, that the export was in accordance with an approved contract, and that Australia's safeguards policy had been fully complied with.

As a result of its recent review of uranium contract pricing policy, the Australian government replaced the previous "determination" with a simple advice to companies setting out the government's requirements relating to pricing and safeguards in commercial contracts. In making these changes, the government has recognized that there is no longer the need for a high degree of government intervention and supervision in the contracting process, thereby

providing Australian producers with much greater flexibility in negotiating future sales contracts.

The Market Environment

The global uranium market is relatively young in comparison with the market for many other mineral commodities such as gold or copper, having been established only in the mid-1960s when the commercial nuclear era began. It is international in scope and highly competitive, with just a handful of producers accounting for the bulk of the world's output. More than 90 percent of Western world production is accounted for by only eight nations, namely, Canada, the United States, South Africa, Australia, France, Niger, Gabon and Namibia. Most of this production is exported. Both Canada and Australia vie for the same markets, principally in Western Europe, the United States, and East Asia.

The demand for uranium is linked directly to the level of electricity produced by the world's nuclear power plants. At the end of 1989, 426 nuclear reactors were in operation worldwide. Since 1986, 71 new nuclear plants have been brought on line worldwide, 12 of those in 1989; an additional 96 nuclear reactors were under construction as of January 1, 1990. In just 30 years, nuclear power's share of total world electricity generation has risen from less than 1 percent to about 17 percent. Western world uranium requirements are expected to increase from an estimated 42,000t U in 1990 to over 50,000t U in 2005.

The uranium market has suffered from oversupply since the late 1970s, when surplus inventories began to accumulate due to delays and cutbacks in reactor construction, and declines in new reactor orders. Although reactor-related requirements have exceeded production since 1985, the drawdown of excess utility inventories has been slower than expected, and a significant surplus still overhangs the market. Moreover, the oversupply situation has been exacerbated recently by the availability of low-priced uranium from the West German uranium stockpile and from non-traditional suppliers, especially the U.S.S.R., certain Eastern European countries and China. In addition, broker/traders have become increasingly active by moving excess inventories and new sources of supply into the market, contributing to volatility in prices on the spot market.

The continued downward pressure on prices, the expiry of high-priced long-term contracts, and the availability of new sources of supply have caused some existing producers to close or curtail their operations. This situation is likely to continue through the mid-1990s, restricting the prospects for market recovery in the short term. Depending on the diversification of procurement

strategies adopted by the world's nuclear utilities, the need for significant new additions to uranium production capacity is not expected until toward the end of this century.

In the longer term, the International Atomic Energy Agency (IAEA) projects that global consumption of electricity will grow at an annual rate in excess of 3 percent, with nuclear-electric generation increasing at just less than 3 percent per annum. Fears about another oil crisis brought on by events in the Middle East, and the heightened awareness that nuclear power plants do not contribute to acid rain or global warming, could contribute to even higher growth. However, it is expected that both the lead times and costs associated with the development of new uranium mining projects will increase, due to the growing interest in protecting the environment and the need for such projects to undergo public environmental review processes.

Uranium Price Trends

The price of uranium is affected to a large extent by the nature of the uranium market itself. Historically, most uranium has been sold by producers under long-term contracts directly to the electrical utilities. Uranium is somewhat unique in that spot sales by producers have accounted traditionally for a relatively small proportion of total deliveries.

Uranium market prices began their general decline in 1979, at which time the NUEXCO Exchange Value (EV) spot-price indicator was at an all-time high approaching US$45 per pound U_3O_8.[8] The build-up of excess inventories in the late 1970s and early 1980s, due to waning demand as orders for new reactors were cancelled or postponed, caused downward pressure on prices. With supply greatly exceeding demand, activity in the spot market increased, consumers disposed of surplus inventory, and uranium prices drifted steadily lower.

The average annual export price for Canadian and Australian uranium slid 20 percent between 1983 and 1989. As illustrated in Figure 4, the NUEXCO EV remained consistently below these average prices, losing more than half its value in the same period. As noted above, broker/traders, representing both the sellers and buyers, became increasingly active in the late 1980s, moving excess material into the market, thus maintaining the downward pressure on prices.

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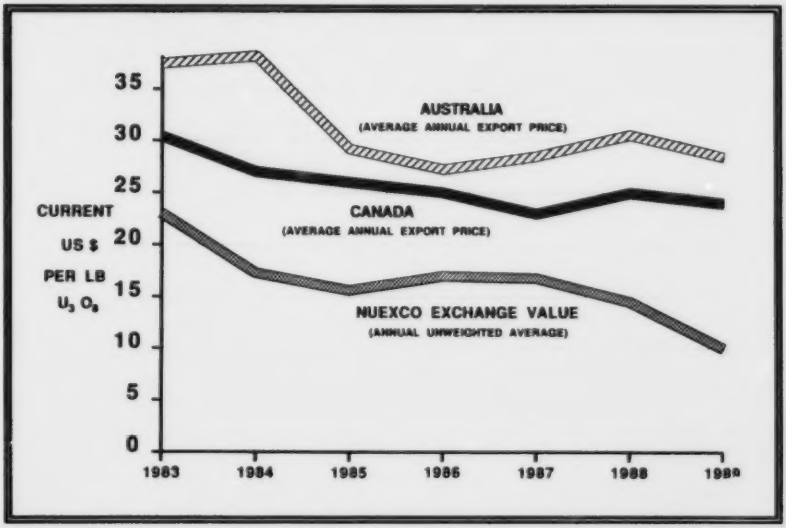
[8] Traditionally, uranium prices are quoted in terms of US$ per pound of U_3O_8. US$ 1/lb U_3O_8 = US$ 2.6/kg U.

Figure 4. Development of uranium prices, 1983-89
Source: NEA/IAEA "Red Book", Paris, 1990.



Until late 1989, when the ready availability of Eastern European uranium became apparent, most analysts expected spot prices per pound of U_3O_8 to bottom out at around US$10, and then gradually recover into the low $20 range, perhaps exceeding US$30 by the end of the century. However, in 1990, spot prices were quite volatile, as reflected by the NUEXCO EV, which hit US$8.70 in February, recovered to US$11.70 in July, fell to an all-time low of US$8.35 in October, but recovered to US$9.70 at year-end.

In attempting to adjust to the unstable market conditions, uranium producers have been trimming output levels, purchasing on the spot market, or closing down production facilities altogether. Even falling uranium output, as production centres close or curtail operations, has done little to bolster prices. In Canada, the average price of all 1990 export deliveries was US$24; less than 1 percent of total export deliveries was under spot sales in 1989 and 1990, compared with 13 percent in 1988, 35 percent in 1987, 21 percent in 1986, and 1.5 percent in 1982.

As noted above (see The Market Environment), prices will likely remain under pressure well into the 1990s because uncommitted demand can be accommodated largely from inventories and non-traditional sources of low-priced uranium. Over the longer term, however, there are prospects for a tightening in the uranium supply situation, which could result in extreme upward pressure on prices toward the end of the decade.

Development Potential

Beyond the existing operations in Canada and Australia, there are several deposits that could be brought on-stream during the 1990s, if warranted by market conditions and, in the case of Australia, if permitted by a change in the government's three-mine policy. In addition, there is significant potential for more uranium discoveries in both countries.

A summary of deposits of the major types discussed in this paper that could reach the production-decision stage in the 1990s is shown in Table 2. As reflected in the table, there is excellent potential for the discovery and development of significant new uranium deposits, the more important of which are the high-grade unconformity-related type uranium deposits, and the uranium-polymetallic breccia-complex deposits.

Canada's uranium producers have been adjusting to the volatile market conditions of recent years. All have trimmed production levels, some have made purchases on the spot market, and others have been forced to close production facilities. Recognizing their contribution to the national economy, the Canadian government has reaffirmed its support for both the uranium and nuclear power industries. Despite the market challenges, Canada has the uranium resources, infrastructure, political stability and determination to be a reliable and competitive supplier of uranium for many years to come.

Table 2. Uranium mining potential in Australia and Canada by deposit type

Types of Deposits	Australia Project/State/Operator	Canada Project/Province/Operator
Unconformity-related type (high- and conventional-grade)	Jabiluka/NT/Pancontinental Koongarra/NT/Denison Kintyre/WA/CRA Exploration	Kiggavik/NWT/Urangesellschaft Midwest/Sask/Denison Wolly/Sask/Minatco Cigar Lake/Sask/Cigar Lake Mining Eagle Point/Sask/Cameco McArthur River/Sask/Cameco
Breccia-complex (polymetallic)	Excellent potential in South Australia (e.g. Olympic Dam) and the Northern Territory	Good potential in the NWT (e.g. Bear Structural Province) and Yukon (e.g. Wernecke Mountains)
Quartz-pebble conglomerate	Occurrences in Northern Territory and potential in Western Australia (e.g. Mentheena Basin) and Queensland	Potential in Ontario (e.g. around Elliot Lake) and in the NWT (e.g. McInnes Lake occurrence)

Australia's uranium producers have spare output capability, although not all have been permitted to expand operations. However, within current policy guidelines, they could collectively double annual production capacity from some 4,000t U to over 8,000t U, depending on the availability of markets. In recognition of the international market realities, the Australian government re-examined its floor-price policy in 1989, announcing that the government would no longer set prices through a predetermined or fixed-floor-price arrangement. The uranium producers in Australia are well positioned competitively to capture new export opportunities, and will continue to make a solid contribution to Australia's economy in the years ahead.

3. Study Specifications

The purpose of this chapter is to introduce the study in terms of the general economic conditions adopted, the representative uranium projects evaluated, and the taxation systems examined.

General Economic Conditions

Money values are expressed throughout in constant 1990 Canadian dollars, with the exception of market prices, which are initially projected in constant 1990 US dollars. Discount and cost-of-capital rates are therefore expressed as real rather than nominal rates.

A 10-percent discount rate is applied in the study's "base case" as a best estimate of the weighted average cost of capital (in constant money terms) for investment in the uranium mining projects. To analyze the sensitivity of results to the cost of capital, assessments are also made for 5-percent and 15-percent rates.[9]

Inflation reduces the constant-money benefits or credits associated with tax write-offs which can only be taken in future years. A 5-percent general rate of inflation is assumed in the study to allow for this reduction in tax credits.

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[9] The weighted average cost of capital in constant money terms comprises the costs of individual sources of funds. Sources of funds may be simply grouped into two types – debt and equity. The cost of debt capital is an explicit interest cost, nominated in current money terms. The cost of equity funds is an implicit opportunity cost which can be estimated empirically.

Considering inflation and taxation effects, debt capital represents a low-cost source of funds, with constant money after-tax costs typically in the range of 1 to 3 percent, seldom exceeding 5 percent. The cost of equity funds typically varies from 6 to 15 percent. The financial structure of a mining company – basically, how much debt and how much equity it utilizes – is applied to cost estimates for the individual sources to assess the weighted average cost of capital.

Empirical assessments of the weighted average cost of capital for large multinational mining companies active in Australia and Canada generally fall within the range of 6 percent to 13 percent. The 10-percent cost of capital normally assumed in this study, as well as the 5-percent and 15-percent variants, should be viewed within this basic framework. See Mackenzie (1990).

Market price projections are required to evaluate the time distribution of revenues for each of the uranium projects. Since price is both the most important and the most uncertain variable in the assessment of cash flows, the evaluations are carried out as a function of price. For this purpose, an expected or mean price outlook is bounded by upper- and lower-limit prices for each mineral commodity.

The market price projections used in the study are presented in Table 3. Note that the copper and gold prices are needed to evaluate a uranium-polymetallic project. The exchange rate is required to convert the US-dollar prices to Canadian-dollar equivalents. Our evaluation procedure assumes constant prices over time at the three different levels specified.

Table 3. Market price projections (US dollars)

Metal	Price Basis	Lower-Limit Prices	Expected Prices	Upper-Limit Prices
Uranium	pound U_3O_8	20	30	40
Copper	pound	0.80	1.00	1.25
Gold	ounce	250	375	500
Exchange Rate	US$/C$	0.90	0.80	0.70

The basis for the uranium price is U_3O_8 content, in the form of yellowcake, as produced at the minesite. For the uranium-polymetallic project, gold is recovered in a copper concentrate. General net smelter conditions for copper concentrate are used to convert the projected copper and gold prices to a revenue estimate for the sale of concentrate at the smelter. Concentrate transportation costs are then deducted to work the smelter payment back to a minesite value.

The uranium market has continued to deteriorate since the study was originally designed in 1989, when we established the assumptions about price. While the uranium estimates may appear high in relation to current spot-market prices, the timeframe for these projections is intended to correspond to the productive lives of the uranium projects being appraised. These developments would only come into production in the mid-1990s and, in all cases, would continue operating well beyond the turn of the century.

Representative Uranium Projects

As outlined in Chapter 2, there are mainly four types of uranium deposit which are of economic interest in Canada and Australia: high-grade unconformity, quartz-pebble conglomerate, conventional-grade unconformity, and uranium-polymetallic. Uranium deposits of each of these types either are known to occur or can be expected to be discovered in both countries.

A uranium mining project profile has been developed for each of the four deposit types. Although the projects are hypothetical, the profiles have been synthesized from several actual situations in order to provide realistic representations of the deposit types.

The representative uranium deposits are assumed to have been discovered and delineated. We are evaluating the economics of investment in the development of these deposits for production. Thus, exploration expenditures and taxation policies relating to exploration expenditures are not considered.[10]

The four case studies have been constructed in a way which makes them most suitable for the tax analysis to be carried out. Thus, for expected market price conditions, the projects are designed to give a good economic spread of before-tax returns, varying from marginally economic to highly profitable.

In order to achieve the desired make-up, the project models tend to be superior examples of the respective deposit types in terms of ore reserve tonnages and grades, and capital and operating costs. Summaries of the uranium project models follow. Their characteristics are outlined in Table 4. More complete project profiles are provided in Appendix I.[11]

High-Grade Unconformity Project

Deposits of this type include Key Lake, Cigar Lake, Collins Bay, and Eagle Point in Saskatchewan, and Narbarlek I and II in the Northern Territory.

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[10] For example, Saskatchewan provides an exploration credit against graduated royalties payable. The payable amount can be reduced by 35 percent of exploration expenditures in the province. This is a significant incentive, the effect of which is not taken into account in this study.

[11] To facilitate revenue calculations for the economic evaluation, ore grades in the representative uranium projects are expressed in percent U_3O_8 rather than percent U. To convert from percent U_3O_8 to percent U, multiply by 0.848.

Table 4. Summary characteristics of representative uranium projects

Characteristic	Uranium Project			
	High-Grade Unconformity	Quartz-Pebble Conglomerate	Conventional-Grade Unconformity	Uranium-Polymetallic
Recoverable ore reserves:				
Size (tonnes)	3,500,000	40,000,000	5,000,000	75,000,000
Grade	2.45% U_3O_8	0.14% U_3O_8	0.50% U_3O_8	0.16% U_3O_8 1.25% Cu 3.0 gpt Au
Mining method	open pit	underground	open pit	under-ground
Capacity (tonnes/year)	250,000	1,500,000	500,000	2,500,000
Preproduction period (years)	3	4	3	4
Preproduction capex ($ million)	619	513	340	872
Employment during production (number of persons)	350	600	250	1,050
Production costs ($/tonne)	305	50	102	70
Mill recovery (%)	98	94	96	94 U_3O_8 90 Cu 75 Au
Recoverable product (tonnes)	84,035	56,640	24,000	110,400 U_3O_8 843,750 Cu 169 Au

The deposit occurs in altered rocks at the intersection of a fault zone with an unconformity, which separates overlying sandstones from underlying metasediments. The mineralized zone extends over 1,200m to a depth of 200m, with a width that varies from 15 to 50m. The principal ore mineral is pitchblende.

The project is situated in a remote location. Consequently, the employees will be airlifted to the mine on a 7-day "in" and 7-day "out" schedule.

The deposit is to be mined by means of an open pit. A very large quantity of waste will have to be stripped to gain access to the ore. The high radiation levels associated with the ore will require special safety precautions.

Pressure oxygen leaching will be used to treat the ore, followed by two-stage solvent extraction. The ore presents process complexities because of extreme grade variability, high mercury content, and the presence of graphite. Because of these intricacies, additional processing stages will be required in order to obtain acceptable recoveries.

Quartz-Pebble Conglomerate Project

Examples of this type include Elliot Lake, Ontario; the McInnes Lake occurrence in the Northwest Territories; Mentheena Basin, Western Australia; and occurrences in the Northern Territory.

The deposit occurs within pyritic quartz-pebble conglomerate beds. A major feature is the uniformity and continuity of the ore-bearing rocks. The average dip of the deposit is 10 degrees. The ore zone is 3 to 8m thick and extends to a depth of 400m. Uraninite and brannerite are the principal uranium ore minerals.

The project is well located with respect to established road, rail, power, housing and townsite facilities. Primary access to the ore zone will be through two vertical shafts located 700m apart. The ore is to be extracted using the room-and-pillar method. A hydrometallurgical acid leach and ion exchange circuit will be utilized to process the ore to a yellowcake product.

Conventional-Grade Unconformity Project

Deposits of this type include Dominique-Peter (Cluff Mining), and Maurice Bay in Saskatchewan; Kiggavik, Northwest Territories; Ranger, Jabiluka I and II, and Koongarra in the Northern Territory; Kintyre, Western Australia; and the Sibley Basin, Ontario.

The deposit comprises several ore zones which occur within crystalline basement rocks. Each zone is 200 to 400m long, 15 to 40m thick, and 20 to 60m wide. They extend to a depth of 140m. The main uranium minerals are pitchblende and coffinite.

The project is situated in a remote location, requiring a "fly-in" work program. The deposit will be mined using conventional open pit techniques. Ore treatment will consist of a standard acid leach-solvent extraction process. The relatively simple mineralogy of the ore will make it possible to obtain a

high uranium recovery with low chemical usage and a straightforward process circuit.

Uranium-Polymetallic Project

Examples of this type include Olympic Dam, South Australia; Port Radium in the Northwest Territories; Wernecke, Yukon Territory; Maureen and Ben Lomond in Queensland; and Coronation Hill, Northern Territory.

The uranium-copper-gold deposit occurs beneath flat-lying barren sedimentary rocks. The mineralization consists of a complex association of fine-grained copper sulphide minerals, uranium minerals, and gold, contained in a 500m-thick sequence of coarse-grained sediments. Ore zones range from 10 to 150m in thickness, have a wide areal extent, and occur throughout the area of mineralization.

The project is situated in a remote location. A new town is to be established about 10km from the minesite to accommodate approximately 4,000 people.

Primary access to the ore will be through two vertical shafts situated 300m apart. A combination of open stoping and cut-and-fill mining methods is to be employed.

The main components of the processing plant will be a concentrator and a flotation tailings circuit. Flotation in the concentrator will produce a copper-gold sulphide concentrate which is to be cleaned to a saleable product by means of a radionuclide removal circuit. The flotation tailings, containing the bulk of the uranium, are to be processed by atmospheric leaching and solvent extraction to recover the uranium as yellowcake.

To recap, two of the deposits would be developed as open pit mines, while the other two would be underground developments. All four projects are very large in scale, as reflected in Table 4 by ore reserve size, capacity, preproduction capital expenditure, direct employment, and the amount of product which would be recovered. Nevertheless, there is a substantial difference in size between the smallest development opportunity (the high- or conventional-grade unconformity project, depending on the yardstick used) and the uranium-polymetallic project.

Taxation Systems

Mining projects in Canada are subject to three main components of taxation:

- federal corporate income tax;
- provincial or territorial corporate income tax;
- provincial or territorial mining tax or royalty.

In Australia, there are two tax components:

- commonwealth corporate income tax;
- state or territorial royalty.

This study focuses exclusively on these components of taxation. Non-profit taxes such as sales, property, fuel, and fringe benefits taxes are not considered.

The following six taxation jurisdictions, three in Canada and three in Australia, are selected for primary attention since they represent the most geologically prospective environments for the types of uranium deposit being evaluated:

- Ontario;
- Northwest Territories;
- Saskatchewan;

- Northern Territory;
- South Australia;
- Western Australia.

Thus, six sets of comparative tax results for each project are presented in the chapters which follow.

In each case, the tax rules applicable at the end of 1990 are used. Saskatchewan is considered to be the "base case" for comparative purposes, incorporating the new uranium royalty regime operative from mid-1989. Taxation of the projects in South Australia is assumed to include the state royalty system specifically enacted for the Olympic Dam mine.

The representative uranium projects are also subjected to four other taxation systems of secondary interest:

- the old uranium royalty regime in Saskatchewan;
- the Saskatchewan metallic minerals royalty, applicable to base metals and gold;
- the Queensland royalty system;

- the general royalty operative in South Australia outside the Olympic Dam mining lease.

Findings for these secondary tax variants are briefly summarized at the end of Chapter 10. Full sets of results are included in the statistical appendices.

In order to classify the actual taxation regimes being analyzed, it is perhaps helpful to first distinguish between three main types of taxation system.

Revenue-Based Taxation:

- traditional *ad-valorem* royalty form of mining taxation;
- taxation is levied at **r** percent of annual sales revenue.

Profit-Based Taxation:

- annual profit is defined as annual sales revenue less allowable deductions for operating costs and capital expenditures;
- taxation is levied at a flat rate of **t** percent of annual profit. Alternatively, the tax rate can be graduated, increasing with the annual level of profit.

Profitability-Based Taxation:

- taxation rate **y** is a function of the relationship between profit and investment or, in other words, of the rate of return on investment;
- profit, investment, and rate of return are defined;
- no tax is levied below a certain threshold rate of return, with the tax rate increasing above that threshold value to a maximum marginal rate for highly profitable projects.

The actual tax systems being studied are now described. A synopsis of each tax component follows. The applicable bases and rates of taxation are summarized in Table 5. Fuller descriptions of the Canadian and Australian taxation systems are presented in Appendices II and III, respectively.

Table 5. Summary of bases and rates for selected taxation systems

Tax Systems	Tax Base	Tax Rate
Canada		
Federal corporate income tax	Profit	28.85%
Ontario corporate income tax	Profit	14.5%
NWT corporate income tax	Profit	10%
Saskatchewan corporate income tax	Profit	15%
Ontario mining tax	Profit	20% above $500,000
NWT mining tax	Profit	0% below $10,000 to 12% above $35 million
New Saskatchewan uranium royalty	Revenue and profitability	5% of revenue, and steps of 0-50% of operating profit based on operating profit/kg U_3O_8
Australia		
Commonwealth corporate income tax	Profit	39%
Northern Territory royalty	Revenue	6.25% of revenue and $1.30/kg of concentrate
South Australia Olympic Dam royalty	Revenue and profitability	2.5% of revenue, and 0-15% of post-threshold project surplus based on project rate of return
Western Australia	Revenue	5%
Tax Systems of Secondary Interest		
Old Saskatchewan uranium royalty	Revenue and profitability	3% of revenue, and steps of 0-50% of operating profit based on ratio of operating profit to capital investment
Saskatchewan metallic minerals royalty	Profit	12.5%
Queensland royalty	Revenue or profit	greater of 2% of revenue or 5% of profit
South Australia general royalty	Revenue	2.5%

Note: profit and profitability tax rates are not comparable because the specific deductions allowable in determining the tax base vary, as do the thresholds for determining graduated rates.

Federal Corporate Income Tax

The calculation of federal corporate income tax payable proceeds as follows. Taxable income is determined by deducting from sales revenues various costs incurred in the earning of income. These costs include

- operating costs;
- capital cost allowance for capital expenditures;
- resource allowance in lieu of provincial mining taxes and royalties;
- interest payments on debt capital;
- exploration expenditures;
- development expenditure allowance;
- carried losses.

A flat rate is applied to this taxable income base to determine the basic federal tax liability. This liability may then be directly reduced by the investment tax credit. However, this tax credit is not presently operative in the provincial jurisdictions under study.

Ontario, Northwest Territories, and Saskatchewan Corporate Income Taxes

Corporate income tax basis in these jurisdictions is the same as defined at the federal level, with provincial and territorial tax liability determined by applying the appropriate tax rate to the federal taxable income base.

Ontario Mining Tax

A new mine is exempt from Ontario mining tax for a period of three years from the start of production. Thereafter, beginning with sales revenues, the tax base is calculated by deducting operating costs, depreciation allowances, exploration expenditures, and a processing allowance. A flat rate is then applied to this taxable income base in excess of a threshold amount.

Northwest Territories Mining Tax

The tax base is determined by deducting various costs from sales revenues including operating costs, depreciation allowances, exploration expenditures,

and a processing allowance. The applicable tax rate is graduated, increasing with the level of taxable income.

New Saskatchewan Uranium Royalty

This new royalty system was enacted in 1990, retroactive to mid-1989. In order to ensure some current tax revenue, a basic royalty is payable on sales revenue. A graduated royalty is then levied on operating profit. Operating profit is defined as sales revenue less the following:

- production costs, including a depreciation allowance for social capital;
- an administrative and corporate expense allowance;
- a marketing expense allowance;
- a working capital allowance;
- a capital recovery allowance.

The graduated royalty rate increases as a function of the operating profit per kilogram of U_3O_8 sold (a proxy for profitability). The basic royalty payment qualifies as a bottom-line credit against the graduated profit royalty which would otherwise be payable.

Australian Taxation Systems

Commonwealth Corporate Income Tax

The calculation of commonwealth corporate income tax proceeds as follows. Taxable income is determined by deducting the following costs from sales revenues:

- state royalty payments;
- operating costs;
- losses carried forward from the previous year;
- new deductions for research and development expenditures, exploration expenditures, capital expenditures for normal depreciable assets, capital expenditures for special mining assets, the cost of transportation and port facilities, and payments for the purchase of mining property.

A flat rate is applied to this taxable income base to determine the amount of commonwealth income tax payable.

Northern Territory Royalty

The imposts for uranium projects comprise a territorial royalty, aboriginal royalties, and a duty to fund environmental monitoring. The territorial royalty is a fixed percentage of sales revenue. The aboriginal royalties, separately negotiated for each uranium mining lease, include a flat rate on sales revenue, as well as initial and annual lease payments. The environmental duty is levied per kilogram of uranium concentrate exported.

South Australia Olympic Dam Royalty

The royalty system legislated for the Olympic Dam project is used for study purposes. As in Saskatchewan, an *ad valorem* royalty is payable on sales revenue to secure a minimum level of tax revenue throughout the mine's productive life. A surplus-related royalty is then levied on the "post-threshold" project surplus. The project surplus is determined by deducting the following costs from sales revenues:

- operating costs;
- the *ad valorem* royalty;
- a commonwealth income tax allowance;
- a depreciation allowance.

The "post-threshold" project surplus is defined as that part of the project surplus which is in excess of the surplus required to secure a minimum acceptable rate of return on investment. The surplus-related royalty rate is a function of the ratio of the project rate of return to the ten-year bond rate.

Western Australia Royalty

For uranium projects, the royalty payable is levied as a flat rate on sales revenue.

Taxation Systems of Secondary Interest

Old Saskatchewan Uranium Royalty

This system was operative for uranium mines in Saskatchewan until mid-1989.

The basic royalty rate applicable to sales revenue is significantly lower than under the new regime. The graduated royalty rate, applicable to operating profit, increases as a function of the rate of return on investment, as measured by the ratio of operating profit to capital investment.

Saskatchewan Metallic Minerals Royalty

The tax base is determined by deducting operating costs, depreciation allowances, exploration expenditures, and a processing allowance from sales revenue. A flat rate is then applied to this taxable income base.

Queensland Royalty

In the case of uranium, the royalty payable is the greater of a percentage of sales revenue and a percentage of net income. Net income is determined by deducting operating costs and a depreciation allowance from sales revenue.

South Australia General Royalty

Except for the Olympic Dam mine, the royalty payable by mines in South Australia is levied as a flat rate on sales revenue.

Individual Project Tax Basis

For profit-based and profitability-based taxation systems, allowable deductions can, generally speaking, be taken either on an *individual project* basis or on an *integrated company* basis. With the individual project (or stand-alone) basis of taxation, deductions can be taken only against production income from the project being evaluated. By *integrated company* we mean a mining company with existing sources of income from other projects. With the integrated company (or flow-through) basis of taxation, allowable deductions can be written off as rapidly as possible against other corporate income. The tax credits realized on an integrated company basis will, therefore, be more

immediate than on an individual project basis. Conversely, the effective tax rate will be lower.

The extent to which the integrated company basis of taxation is applicable depends on several factors.

- Level of corporate income. If the projects being evaluated are large, anticipated corporate income from other sources may be insufficient to fully absorb allowable tax deductions from the project.

- Source of corporate income. The timing of deductions is further constrained by where the anticipated income comes from and by the type of income. For example:
  - income in Canada is required to take deductions for federal corporate income tax;
  - income in Ontario is required to apply write-offs for Ontario corporate income tax;
  - *mining* income in Ontario is needed for a company to use deductions to reduce Ontario mining tax payments.

- Government policy constraints. Taxation rules may further limit the degree to which corporate income can be "pooled" and deductions taken. For example, the timing advantage of the integrated company basis of taxation is greatly restricted in the case of Australian income tax by the policy provision that deductions for most capital expenditures can be taken only from the time that assets are first put into use.

The actual tax treatment of mining projects varies through a wide range, from the individual project situation on the one hand to the fully integrated company scenario on the other. While it would be interesting to examine the sensitivity of project economics and effective tax rates to different degrees of deductibility against other corporate income, we have not attempted to do so here.

The study assumes that the representative uranium mining projects are taxed on an *individual project* basis. Thus, the company concerned is considered to be a new entrant with no other relevant anticipated source of income.

Other Tax Assumptions

Several other tax assumptions have to be made to enable some of the Canadian and Australian tax systems to be applied.

- "prime rate" of 12 percent is used for purposes of calculating taxes in Saskatchewan under the new and old provincial uranium royalty regimes;[12]

- a "ten-year bond rate" of 10 percent is applied to determine royalty payments for the South Australia Olympic Dam royalty;[13]

- for purposes of calculating Saskatchewan uranium royalties, the following "social infrastructure" capital expenditures have been assumed as part of overall preproduction capital expenditures:

Uranium Project	Social Infrastructure Capital Expenditure ($ million)
High-grade unconformity	10
Quartz-pebble conglomerate	5
Conventional-grade unconformity	10
Uranium-polymetallic	80

- in order to determine commonwealth corporate income tax in Australia, the "mine plant and equipment" component of preproduction capital expenditures is considered to include the following proportions of "heavy duty" machinery: 30 percent for the open pit projects, and 15 percent for the underground developments;

- the following breakdowns of preproduction "infrastructure" capital expenditures are used for calculating Australian corporate income tax ($ million):

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[12] Obtained by averaging the Canadian prime lending rate over the 1980-89 period, making appropriate adjustments for inflation. This rate is assumed to remain fixed as the cost of capital is varied.

[13] Obtained by averaging the long-term Australian government bond rate over the 1979-88 period, making appropriate adjustments for inflation. This rate also is held constant as the cost of capital is changed.

Uranium Project	Social Infrastructure	Power and Water	Transportation Facilities
High-grade unconformity	10	80	42
Quartz-pebble conglomerate	5	35	5
Conventional-grade unconformity	10	50	25
Uranium-polymetallic	80	120	86

- the new and old uranium royalty systems in Saskatchewan make no provision for the recovery and sale of by-products. For study purposes, the uranium-polymetallic project is treated as a "uranium" mine. Byproduct copper and gold revenues are included in determining "operating profit". For the new Saskatchewan system, these byproduct revenues also are converted to "equivalent kilograms of U_3O_8 sold" to determine the "graduated profit royalty";

- in Queensland and Western Australia, revenues realized from the uranium-polymetallic project are considered to be attributable to "uranium".

4. Evaluation Procedure

This chapter outlines the study methodology, and briefly describes the economic indicators and taxation criteria which are used to present and compare results.

General Approach

The evaluation is carried out in two stages.

In the first stage, general economic conditions and deposit-specific characteristics (specified in Appendix I) are applied to evaluate each of the uranium projects on a potential value or before-tax basis. In each case, a before-tax time distribution of cash flows is derived from the market price, ore reserve, capital expenditure, and operating cost estimates. Indicators of the economic attractiveness of the project are then assessed from this cash flow distribution.

The uranium projects are initially evaluated for "base case" conditions, including expected market prices and the 10-percent cost of capital. The sensitivity of the before-tax indicators to possible variations in price and cost of capital is then examined.

In the second stage of evaluation, the taxation systems in each of the selected Canadian and Australian jurisdictions (specified in Appendices II and III) are applied in turn to the before-tax conditions. In each case, the after-tax time distribution of cash flows is determined. After-tax economic indicators are appraised for each uranium project in the various tax jurisdictions, and results are compared with the before-tax potential previously assessed. It is of particular interest to recognize situations which are potentially economic but become uneconomic after tax. Several taxation criteria, based on the government revenues generated, are also assessed to examine the incidence and components of taxation for comparative purposes.

To provide an after-tax standard for comparison, the taxation system in Saskatchewan (including the new uranium royalty regime) is selected as the "base case", together with the base case specifications adopted on a before-tax basis. Results are then evaluated and presented for each of the other tax jurisdictions. The sensitivity of findings to the market price and cost-of-capital variants is once again analyzed.

Economic Indicators

The economic indicators outlined here are intended to measure the attractiveness of the representative uranium projects on both before- and after-tax bases from an investment incentive, private sector, mining company perspective.

Cash Flow Criteria

A number of economic criteria can be assessed from the projected time distribution of cash flows. The two indicators outlined below are used in the present study.

Total Revenue

The size of a mining project is often a relevant consideration in decision-making. Size may be measured in various ways. The total revenue that a mine is anticipated to generate over its life provides an economic indicator of project size which is distinct from profitability considerations. Total revenue is simply the summation of annual revenues estimated over a mining project's productive life.

Total Cash Flow

Profit, for purposes of economic analysis, is measured by cash flow. The summation of projected annual cash flows (either before- or after-tax) represents the total profit anticipated from a mining project. While this "total cash flow" criterion makes no allowance for the cost of capital, it is nevertheless a useful indicator of economic potential.

DCF Criteria

Discounted cash flow (DCF) methods overlay time-value considerations on the estimated cash flow profile for a project in a variety of ways in order to compare the cost of capital and the return on investment. The following two DCF indicators are used for study purposes.

Net Present Value

The net present value criterion converts the anticipated time distribution of cash flows for a mining project into an equivalent value at the start of development. To make the conversion, each cash flow is discounted back to this point using the cost of capital rate. The present value components are then summed to yield the net present value. Thus, net present value is the difference between the discounted positive cash flows from production and the discounted preproduction capital expenditures. Net present value measures the monetary value or economic worth of a mining project. It represents the anticipated return on investment over and above the minimum required return. Net present value reflects both the size and profitability characteristics of a project. *Using this criterion, the minimum acceptable condition for an economic project is a net present value equal to zero.*

Rate of Return

In economic terms, rate of return measures the average annual percentage return on investment that a project is anticipated to yield over its total life. It is defined as the discount rate which equates the present value of the positive cash flows from production with the present value of the preproduction capital expenditures. In other words, rate of return is the discount rate which produces a zero net present value. Unlike the other DCF methods such as net present value, the rate of return is determined solely on the basis of the estimated time distribution of cash flows for a project. *Using this criterion, the minimum acceptable condition for an economic project is a rate of return equal to the cost of capital.*

Although several other economic indicators have been evaluated for each of the uranium project situations, it was decided not to present further results. These other indicators include payback period, equivalent annual return on investment, and present value (or profitability) ratio.

Taxation Criteria

The taxation criteria outlined here are intended to measure the characteristics of the representative uranium projects on an after-tax basis from a public sector, government revenue, mineral policy perspective.

Government Tax Revenues

For each uranium project situation evaluated on an after-tax basis, a time distribution of tax payments is calculated in order to determine the after-tax cash flow distribution. This tax payments stream is given direct attention here.

In each case, summation of the projected stream of taxes gives "total undiscounted tax payments", making no allowance for time value. The annual taxes are also discounted back to the start of development at the assumed cost-of-capital rate in order to measure "total discounted tax payments".

The components of total tax revenues are also compiled on the same undiscounted and discounted bases as the totals. There are three components for the Canadian jurisdictions: federal income taxes, provincial income taxes, and provincial mining taxes and royalties. In Australia, there are two tax components: commonwealth income taxes, and state royalties.

Government tax revenues, discounted to the start of development at a number of rates besides the cost-of-capital rate have also been evaluated. However, it was decided not to present these further results.

The three taxation measures outlined below are derived from these basic assessments of government tax revenues.

Effective Tax Rates

The impact of taxation on the economics of each uranium project situation can be measured by the "effective tax rate". For study purposes, the effective tax rate is defined as the discounted taxes divided by the before-tax net present value of the project. Both the tax payments and the project cash flows are time-adjusted by the cost-of-capital rate.[14]

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[14] The effective tax rate as defined here is an *average* rate. This criterion should be clearly distinguished from the *marginal* effective tax rate as employed, for example, in Boadway, McKenzie and Mintz.

The *marginal* rate is based on the amount of tax which would be paid on the income generated from the last increment of investment (i.e., the marginal increment) in a project. This approach is suited to measuring the extent to which taxation may distort the optimization of development specifications and investment for projects. While this is an important type of policy issue, the level of detail required for meaningful empirical analysis, including the estimation of production functions for the projects to be examined, is beyond the scope of the present study.

Our study focuses on the effect of taxation on competitive position and economic viability for uranium mining based on four project models, each of which simply is assumed to have a fixed set of development specifications and a fixed investment requirement. We have chosen to use the *average* tax rate because it provides a comprehensive measure of

The effective tax rate provides a clear indication of the burden of taxes imposed in each case. Differences in the effective tax rate among jurisdictions reflect differences in competitive position.

Overall effective tax rates are evaluated using total tax payments. It is also of interest to compare the breakdown of overall tax rates among jurisdictions by level of government and by type of payment.

Another important issue is the extent to which taxation of uranium mining in Canada and Australia may distort mining company investment decisions. If the effective tax rate on projects which are just economic before tax is positive, then the tax system provides a disincentive to invest. Under these conditions, projects which are economic on a before-tax basis can become uneconomic after tax. This represents an important type of government policy inefficiency.

More generally, it is of interest to examine trends in the effective tax rate as a function of the before-tax profitability of projects. A "progressive" tax collects an increasing proportion of before-tax net present value as profitability rises. On the other hand, a "regressive" tax takes a decreasing proportion of before-tax net present value as profitability rises. Regressive tax systems tend to have their strongest impact at the investment margin, resulting in economic distortions and inefficiencies.

Intergovernmental Tax Shares

A further issue of importance to Canadian and Australian mining tax policy concerns the division of government tax revenues. Tax payments, time-adjusted to the start of development at the cost-of-capital rate, are the basis adopted in this study for determining intergovernmental tax shares.

Since there are three tax components in Canada and only two components in Australia, Canadian tax payments are grouped in two different ways to provide consistent bases for measuring intergovernmental tax shares.

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comparative tax levels among jurisdictions and, therefore, is a worthwhile indicator of the tax component of competitive standing. Of course, high average tax rates may reflect, in part, high economic returns earned on projects. Even though average rates of tax are high, sufficient incentive may remain to undertake investment. Nevertheless, differences in the average effective tax rate among jurisdictions do indicate differences in competitive position.

Within our modelling constraints, we also are interested in the distorting effects of taxation on the economic viability of projects and investment decisions. This issue is addressed by employing DCF criteria to highlight those uranium project situations which, while potentially economic to develop, would not justify investment on an after-tax basis. Also, we examine changes in the average tax rate as a function of profitability in order to differentiate between progressive and regressive systems of taxation.

By level of government:

Division of total taxes between the federal or commonwealth government on the one hand, and by the provincial, territorial, or state government on the other.

By type of tax payment:

Division of total taxes between corporate income tax on the one hand, and provincial, territorial, or state mining tax and royalty on the other.

Comparative Tax Levels

In order to directly address the competitive position issue, the incidence of taxation is compared among the various Canadian and Australian jurisdictions. Comparative tax levels are determined on the basis of tax payments, time-adjusted to the start of development at the cost-of-capital rate.

Government tax revenues in Saskatchewan are assigned an index of 100. Tax payment indexes in the other jurisdictions are then measured relative to this base. These comparative tax levels are calculated for total taxes as well as for each component which makes up this composite picture, by level of government and by type of payment.

Study Results

The study methodology is applied to the four uranium project situations. In each case, the economic indicators and taxation criteria described above are evaluated. The results are compiled in Appendices IV to IX. Chapters 5 to 10 focus on several of the possible findings that can be drawn from them. The statistical appendices provide ingredients for policy analysts interested in other facets of the topic.

5. Before-Tax Evaluation of Projects

The four representative uranium projects are evaluated here on a potential value or before-tax basis. A complete set of numerical results is tabled in Appendix IV.

Base Case Results

The base case conditions, which are used as a standard of comparison with other results, include expected market prices (Table 3) and a 10-percent cost of capital.

For these conditions, the cost and revenue characteristics for each project are combined to assess the time distribution of cash flows. These distributions, presented in Figure 5, give a general impression of the relative size and profitability characteristics of the projects.

The summation of annual cash flow components over the life of each project is portrayed in Figure 6. After allowing for capital expenditures and production costs, the cash flow generated represents a sizeable chunk of sales revenue, varying from 43 percent for the quartz-pebble conglomerate project to 76 percent for the high-grade unconformity project. However, these total undiscounted values make no allowance for the cost of capital.

The before-tax economic indicators evaluated are summarized in Table 6. By normal mining standards, these are all very large projects. In terms of total sales revenue, they rank as follows:

1. Uranium-Polymetallic Project ($12.8 billion)
2. High-Grade Unconformity Project ($6.9 billion)
3. Quartz-Pebble Conglomerate Project ($4.4 billion)
4. Conventional-Grade Unconformity Project ($2.0 billion)

Note that there is about a six-times size difference between the smallest and the largest project.

Figure 5. Before-tax cash flow distributions under base case conditions

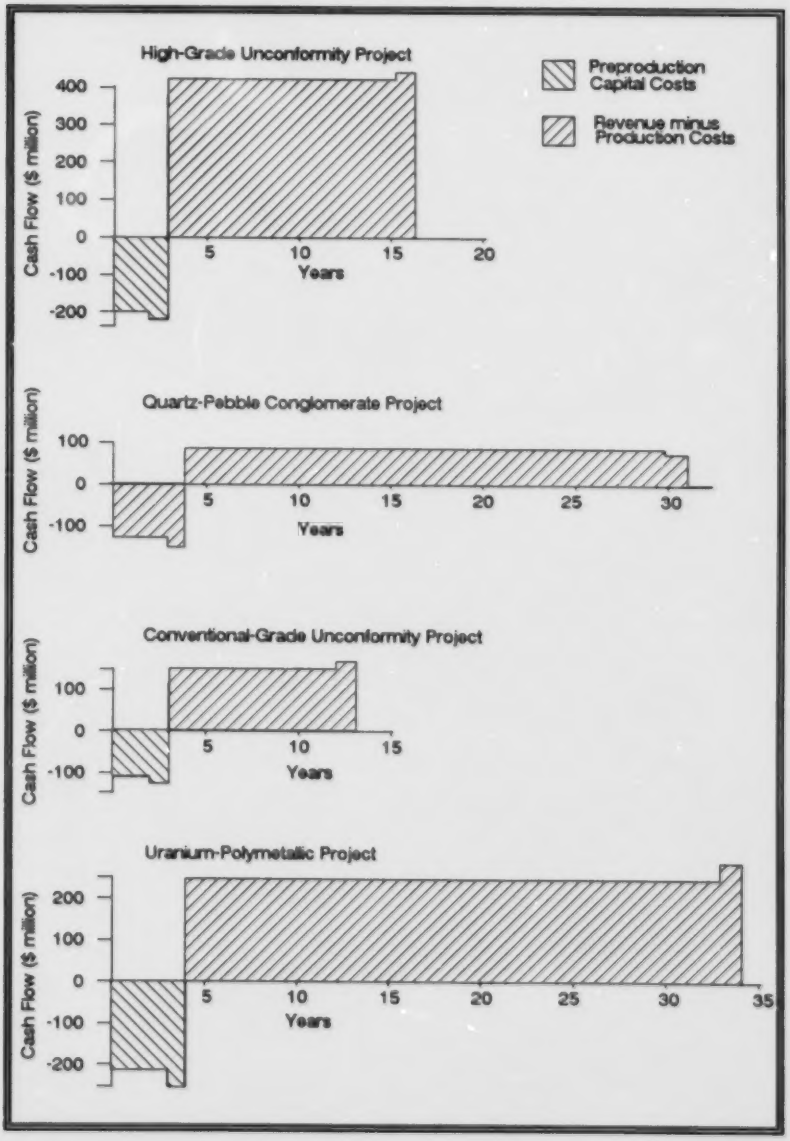


Figure 6. Total cash flow components before tax under base case conditions

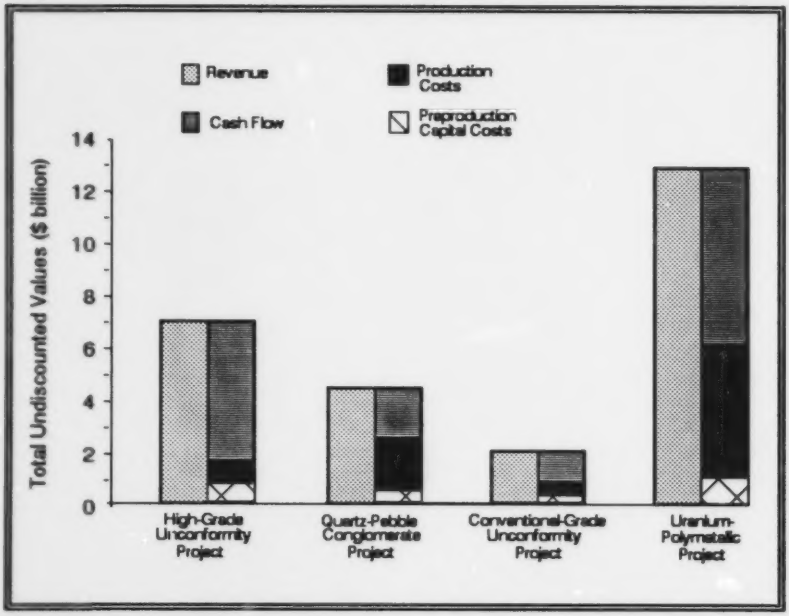


Table 6. Before-tax economic indicators under base case conditions

Indicator	Uranium Project			
	High-Grade Unconformity	Quartz-Pebble Conglomerate	Conventional-Grade Unconformity	Uranium-Polymetallic
Net revenue ($ million)	6,947	4,352	1,984	12,763
Undiscounted cash flow ($ million)	5,281	1,856	1,149	6,682
Net present value at 10% ($ million)	1,817	151	404	928
Rate of return (%)	45	14	31	21

All of the projects are shown to be economic on a before-tax basis under the assumed base case conditions. In terms of profitability, the projects vary from highly profitable to marginally economic, ranking as follows on the basis of rate of return.

1. High-Grade Unconformity Project (45%)
2. Conventional-Grade Unconformity Project (31%)
3. Uranium-Polymetallic Project (21%)
4. Quartz-Pebble Conglomerate Project (14%)

These mine development opportunities have the potential to create substantial amounts of new wealth. This potential value is measured by the net present value criterion – the difference between the revenues realized from uranium production and all the costs required to realize that revenue, including the allowance for the cost of capital (10 percent in this case). The projects rank as follows in terms of potential net present value.

1. High-Grade Unconformity Project ($1,817 million)
2. Uranium-Polymetallic Project ($928 million)
3. Conventional-Grade Unconformity Project ($404 million)
4. Quartz-Pebble Conglomerate Project ($151 million)

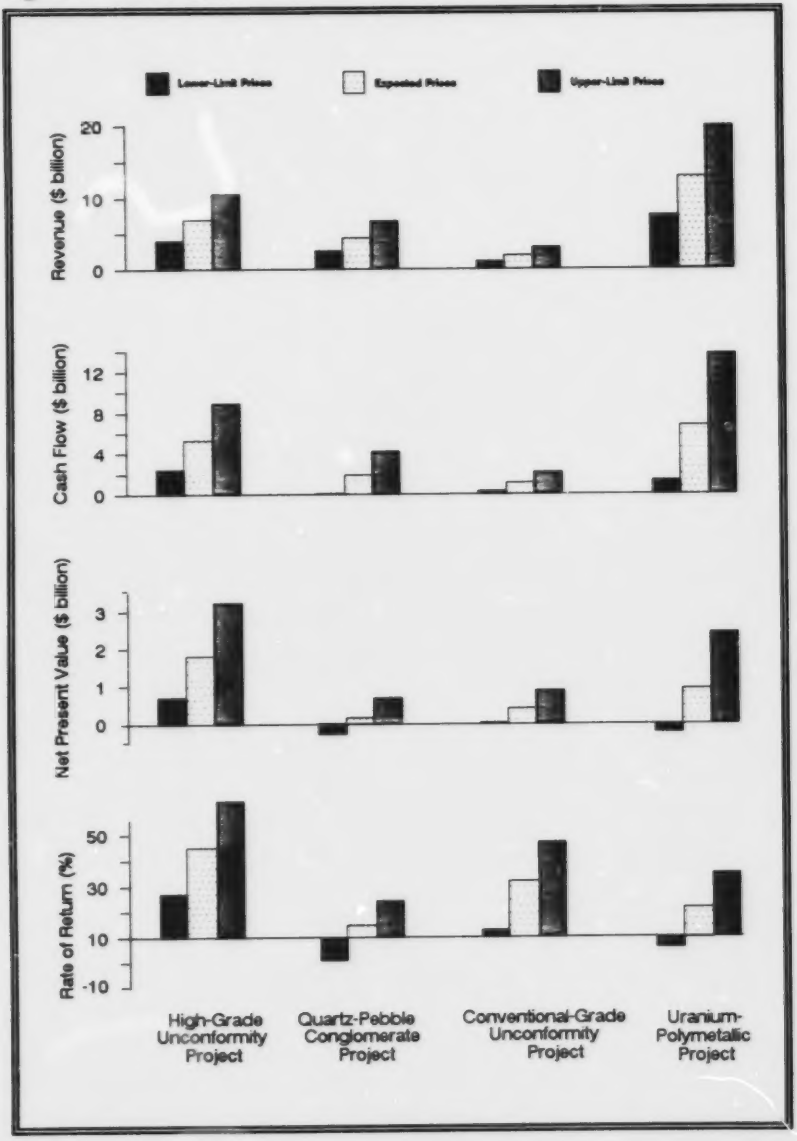
Market Price Variants

The expected market prices used in the base case represent highly uncertain "best" estimates. Potential value assessments for the projects as a function of the lower-limit, expected, and upper-limit market price conditions specified in Table 3 are shown in Figure 7.

These results indicate high degrees of sensitivity of total revenue, undiscounted cash flow, net present value, and rate of return to the market price variants. The quartz-pebble conglomerate and uranium-polymetallic projects would be uneconomic if lower-limit prices prevailed. On the other hand, the upside potential associated with the optimistic price conditions is shown to be considerable.

The changes in revenue become magnified in the other three economic indicators. For example, at lower-limit prices, total revenue is about 41 percent lower than at expected prices, whereas the corresponding decline in net present value varies from 62 percent for the high-grade unconformity project to 277 percent for the quartz-pebble conglomerate project. Also note that the degree of sensitivity of undiscounted cash flow, net present value, and

Figure 7. Before-tax economic indicators as a function of market price



rate of return to market price is an inverse function of profitability. In other words, the economic indicators for the less profitable projects are affected to a relatively greater extent than the economic indicators for the more profitable cases.

The uncertainty associated with uranium price projections represents a critical risk in corporate planning and government policy analysis. Flexibility should be incorporated in plans and policies to accommodate the resolution of price uncertainties with time.

Cost-of-Capital Variants

A constant money cost of capital of 10 percent is used in the base case to evaluate the economic potential of the uranium projects. To analyze the sensitivity of study results to the cost of capital, assessments are also made for 5-percent and 15-percent rates.

Net present value is the only one of the economic indicators used here which is dependant on the cost of capital. As the cost of capital is raised, the net present value decreases. The sensitivity of net present value to the cost of capital is illustrated in Figure 8.

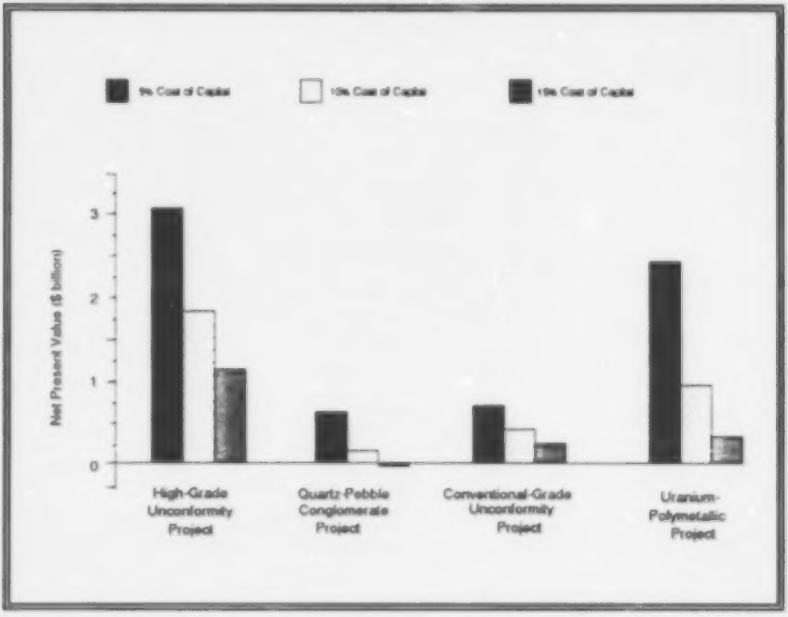
The economic potential of the uranium projects is found to be very sensitive to the discount rate. If the cost of capital were as high as 15 percent, the quartz-pebble conglomerate project would be uneconomic. As was the case for the metal price variants, the net present values for the less profitable projects are affected to a relatively greater extent than the net present values for the more profitable opportunities. For example, at a 5-percent cost of capital, the net present value for the quartz-pebble conglomerate project is 301 percent higher than at the 10-percent discount rate, whereas the corresponding increase for the high-grade unconformity project is only 67 percent.

Summing Up

By normal mining standards, the four representative uranium projects are all very large. There is about a six-times difference in the revenue-generating attribute of these potential mines.

All of the projects are economic before tax under the assumed base case conditions. For these conditions, the mine development opportunities range from highly profitable to marginally economic. They are all shown to have the potential to create substantial amounts of new wealth.

Figure 8. Before-tax net present value as a function of the cost of capital



The economic indicators evaluated, especially net present value, are found to be highly sensitive to future market price possibilities. The economic indicators for the less profitable projects are affected by price to a relatively greater extent than the economic indicators for the more profitable cases. Two of the projects would be economic if lower-limit prices prevailed.

The economic potential of the uranium projects is also found to be sensitive to the cost of capital. At 15 percent, one of the four development opportunities would be uneconomic.

6. After-Tax Evaluation of Projects

This chapter evaluates what the potential, before-tax assessments presented in Chapter 5 mean in terms of after-tax incentive to the mining company contemplating investment in the four uranium projects. A complete set of after-tax results is presented in Appendix V.

Base Case Results

The after-tax base case evaluates the representative uranium projects for the tax conditions which exist in Saskatchewan. The other base case conditions are as specified in the before-tax appraisal.

The after-tax cash flow distributions for Saskatchewan base case conditions are illustrated in Figure 9. The summation of annual cash flow components over the life of each project is portrayed in Figure 10. The reduction in cash flows is shown to be very substantial in all cases. The degree of reduction is a function of the before-tax profitability of the projects. After-tax cash flow expressed as a share of the before-tax value varies from 45 percent for the quartz-pebble conglomerate project to 36 percent for the high-grade unconformity project.

The after-tax economic indicators are summarized in Table 7. The quartz-pebble conglomerate project, potentially economic for base case conditions, is uneconomic on an after-tax basis. In the other cases, the after-tax net present value is less than one third of the before-tax values. The after-tax rate of return varies from 58 percent of the before-tax return for the conventional-grade unconformity project to 71 percent of the before-tax potential value in the case of the uranium-polymetallic project. It is interesting to note that Saskatchewan tax conditions have the greatest impact on the rate of return for the two unconformity projects, which are the predominant resource-type in Saskatchewan.

Figure 9. After-tax cash flow distributions under base case conditions

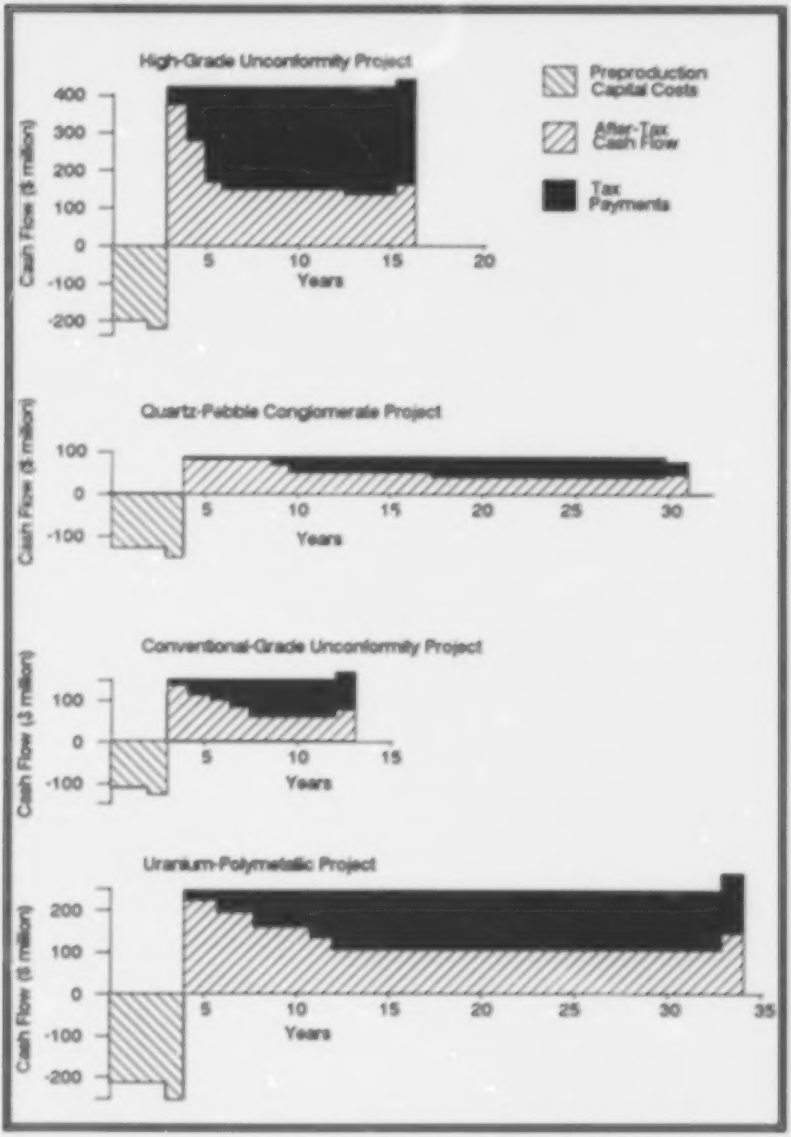


Figure 10. Total cash flow components after tax under Saskatchewan base case conditions

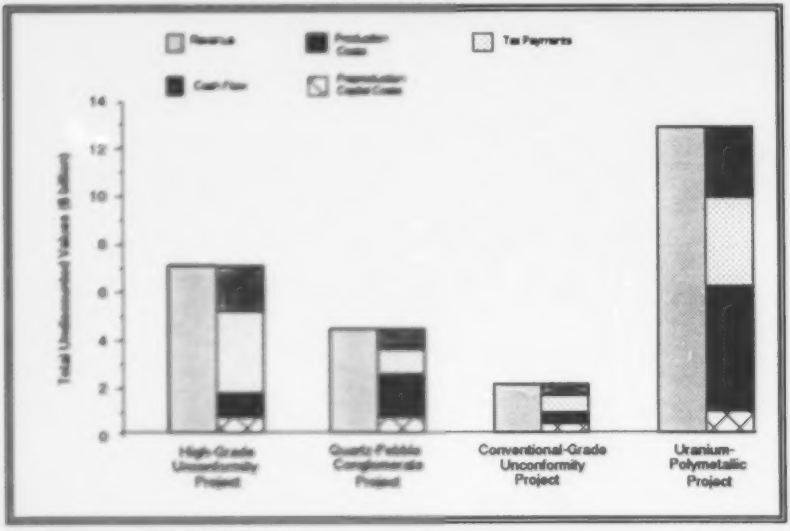


Table 7. Effect of taxation on economic indicators under Saskatchewan base case conditions

Indicator	Uranium Project			
	High-Grade Unconformity	Quartz-Pebble Conglomerate	Conventional-Grade Unconformity	Uranium-Polymetallic
Net present value at 10% ($ million)				
Before tax	1,817	151	404	928
After tax	589	-21	116	285
Rate of return (%)				
Before tax	45	14	31	21
After tax	28	9	18	15

Results among Jurisdictions

After-tax economic indicators for each of the uranium projects in each of the six tax jurisdictions are presented in Table 8.

The quartz-pebble conglomerate project, uneconomic after tax in Saskatchewan and the three Australian jurisdictions, would be marginally economic in the Northwest Territories and Ontario.

The variations in after-tax results among the jurisdictions are considerable. For example, the after-tax net present values of the projects range as follows:

- for the high-grade unconformity project, from $589 million in Saskatchewan to $1,040 million in the Northwest Territories;
- for the quartz-pebble conglomerate project, from −$52 million in the Northern Territory to $27 million in the Northwest Territories;
- for the conventional-grade unconformity project, from $116 million in Saskatchewan to $208 million in the Northwest Territories;
- for the uranium-polymetallic project, from $277 million in Australia's Northern Territory to $454 million in the Northwest Territories.

The taxation policies in the Northwest Territories provide the greatest incentive for investment while the regimes in Saskatchewan and the Northern Territory are found to be the least encouraging. Ontario is also in a favourable position, while the South Australia and Western Australia taxation systems place them towards the middle of the investment-incentive spectrum.[15]

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[15] These findings pertain to the impact of taxation on the incentive to invest in new mine development. The post-discovery orientation of the analysis ignores the longer-term issues which relate to the motivation of investment in uranium exploration. Exploration is driven in large measure by the lure of spectacular returns from a rare discovery. In this respect, a progressive profitability-based tax system (uranium royalties in Saskatchewan, for example) would tend to inhibit exploration by disproportionately reducing the potential for these extraordinary finds to yield substantial excess profits. On the other hand, study findings demonstrate that progressive tax systems (especially those that have favourable write-off provisions for past and current exploration expenditures, as is the case in Saskatchewan) increase the chances of turning a discovery into a mine by giving relief at the investment margin.

Table 8. Effect of taxation on economic indicators among jurisdictions under expected conditions

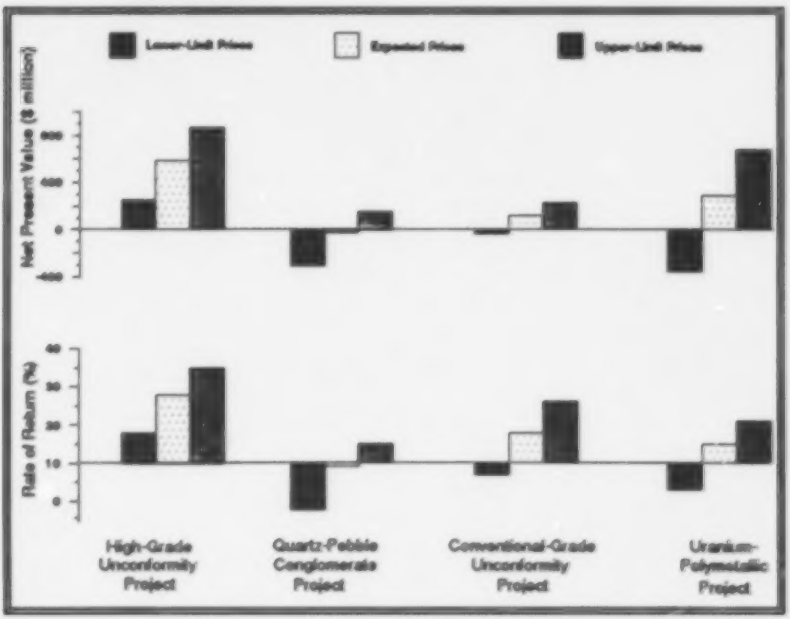
Indicator	Uranium Project			
	High-Grade Unconformity	Quartz-Pebble Conglomerate	Conventional-Grade Unconformity	Uranium-Polymetallic
Net present value at 10% ($ million):				
Before-tax results	1,817	151	404	928
After-tax results				
Ontario	951	1	190	379
Northwest Territories	1,040	27	208	454
Saskatchewan	589	-21	116	285
Northern Territory	865	-52	139	277
South Australia	875	-28	155	333
Western Australia	912	-34	155	337
Rate of return (%):				
Before-tax results	45	14	31	21
After-tax results				
Ontario	35	10	22	16
Northwest Territories	35	11	18	17
Saskatchewan	28	9	18	15
Northern Territory	30	8	19	14
South Australia	31	9	20	15
Western Australia	31	9	19	15

Market Price Variants

The sensitivity of the after-tax economic indicators to lower-limit, expected, and upper-limit market price conditions is illustrated in Figure 11. A high degree of sensitivity is once again observed, more critical than on a before-tax basis because the after-tax results are closer to the investment margin.

The quartz-pebble conglomerate and the uranium-polymetallic projects, which were uneconomic at lower-limit prices on a before-tax basis, are even less interesting after tax. The conventional-grade unconformity project, potentially economic, is found to be uneconomic after tax in all jurisdictions.

Figure 11. After-tax economic indicators in Saskatchewan as a function of market price

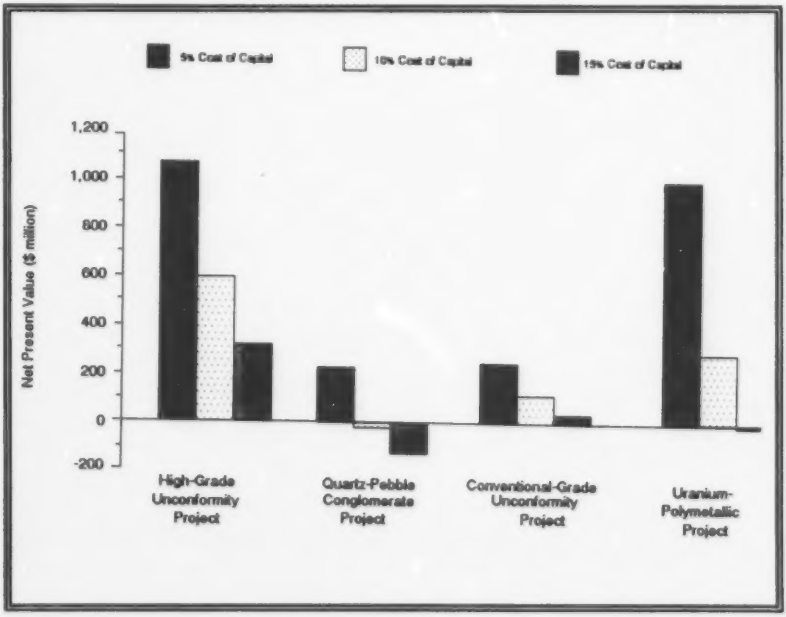


Cost-of-Capital Variants

Figure 12 portrays the sensitivity of after-tax net present value to the cost of capital as the discount rate is varied from 5 to 15 percent. Net present value is again very sensitive to the cost of capital, the downside variations being more critical than the before-tax results relative to the economic margin.

For the 15-percent cost of capital, the quartz-pebble conglomerate project, uneconomic before tax, is even less attractive on an after-tax basis. Also, the uranium-polymetallic project, potentially economic, is driven below the investment margin after tax by the 15-percent cost of capital.

Figure 12. After-tax net present value in Saskatchewan as a function of the cost of capital



Summing Up

The taxation policies in the Northwest Territories provide the greatest incentive for investment while the regimes in Saskatchewan and the Northern Territory are found to be the least favourable. Perhaps these comparative results are not surprising. High remoteness costs are associated with mine development in the Northwest Territories. On the other hand, the Saskatchewan and Northern Territory taxation systems have no doubt been designed at least in part for the relatively profitable unconformity-related uranium deposits which are known to occur in these jurisdictions. Ontario is also shown to be in a relatively encouraging position, while the taxation systems in South Australia and Western Australia give them a more central place in the spectrum of after-tax investment incentive.

Several of the uranium project situations which were shown in Chapter 5 to be potentially economic become uneconomic on an after-tax basis. The distorting effects of taxation on private sector investment decisions, illustrated here, represent an important inefficiency of existing government taxation policies.[16] To the extent that taxation policies act in this way, the actual value realized from the mineral sector is less than the potential value which exists. This diminishes the wealth-creating, employment, income, and foreign exchange benefits generated by mining.

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[16] There is another type of policy distortion, beyond the scope of this study, which may be of considerable consequence. Each of our four uranium project models is defined by a fixed set of development specifications. In reality, mining companies endeavour to optimize those specifications which are controllable, such as mine capacity, mining method, and cut-off grade. How then do the level and structure of mining taxation change the project specifications in relation to the before-tax optimum? Regressive tax systems, particularly those which are revenue-based, tend to encourage smaller, high-grade development scenarios. On the other hand, progressive profitability-based regimes may provide a strong incentive for larger, more capital-intensive project scales. Could this distortion be significant enough in world markets to cause commodity prices and mining profits to fall generally? This important question in the context of the international uranium market warrants a study of its own.

7. Government Tax Revenues

Attention is directed in this chapter to the tax payments assessed in order to determine the after-tax results presented in Chapter 6. These payments made from project income are costs to the investor or mining company, but represent revenues to the governments concerned.

The before-tax net present values for the uranium projects presented in Chapter 5 are distributed in two basic ways. The private sector retains the after-tax net present values evaluated in Chapter 6. The balance, considered in this chapter, represents time-adjusted government tax revenues.

A complete set of undiscounted and discounted government tax revenue results is tabled in Appendix VI.

Base Case Results

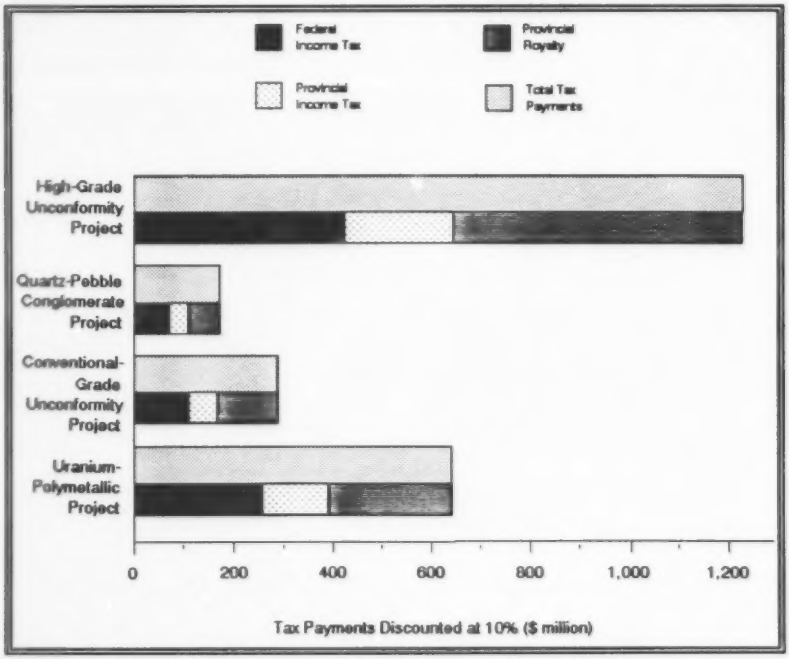
The tax revenues which would be generated from the development of the uranium projects in Saskatchewan under base case conditions are illustrated in Figure 13. The total government revenues, time-adjusted to the start of development, are shown to be substantial, varying from $172 million for the quartz-pebble conglomerate project to $1,228 million for the high-grade unconformity project. The Saskatchewan uranium royalty and the federal income tax account for the largest shares of the government revenues created by the four representative projects.

Results among Jurisdictions

Comparative tax revenues among the seven Canadian and Australian jurisdictions are portrayed in Figure 14. The substantial degree of variability in government revenues shown can be summarized as follows:

- for the high-grade unconformity project, total discounted taxes vary from $777 million in the Northwest Territories to $1,228 million in Saskatchewan;

Figure 13. Government tax revenues under Saskatchewan base case conditions



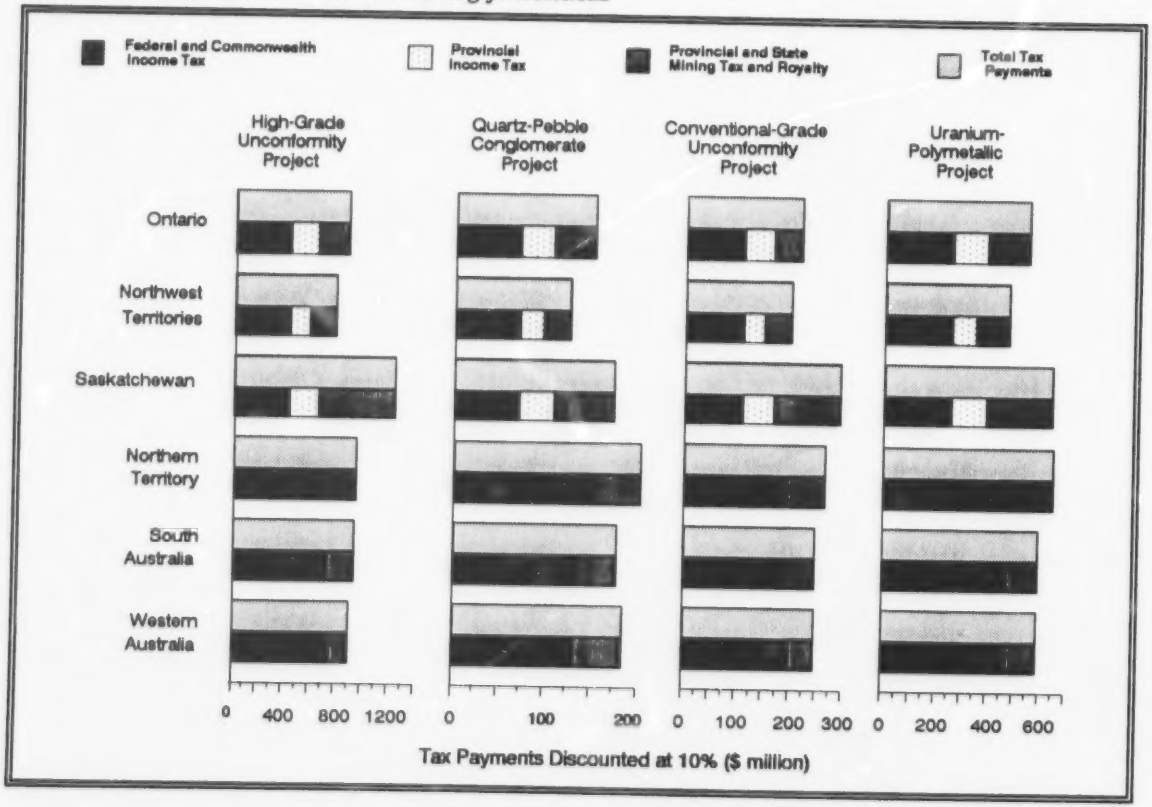
- in the case of the quartz-pebble conglomerate project, taxes would range from $124 million in the Northwest Territories to $203 million in Australia's Northern Territory;

- for the conventional grade unconformity project, government revenues vary from $196 million in the Northwest Territories to $289 million in Saskatchewan;

- in the case of the uranium-polymetallic project, discounted taxes range from $474 million in the Northwest Territories to $651 million in the Northern Territory.

Variations among the Australian jurisdictions are somewhat less pronounced than they are in Canada. Also, note that there are fundamental differences in the composition of the tax totals. The division of government tax revenues will be discussed further in Chapter 8.

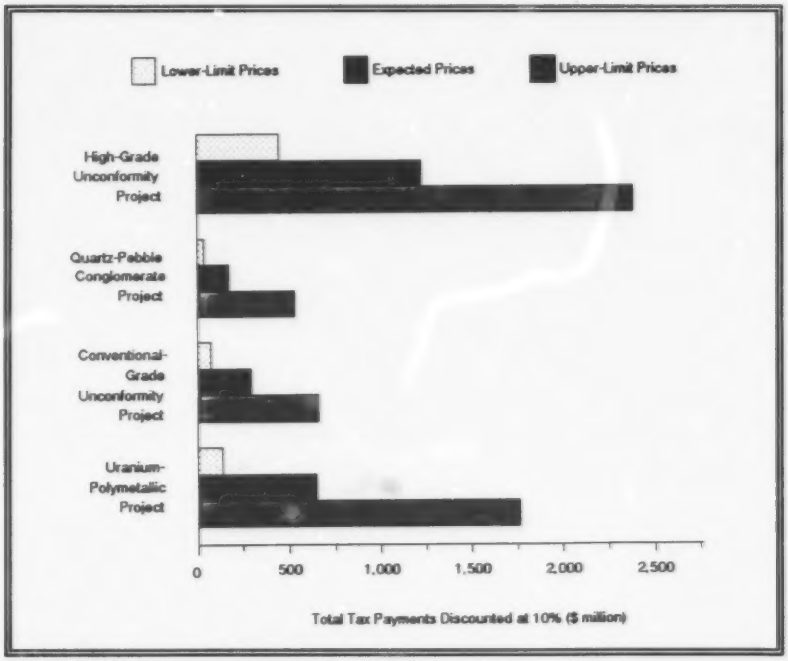
Figure 14. Government tax revenues among jurisdictions



Market Price Variants

The sensitivity of taxes to future market price possibilities for Saskatchewan tax conditions is illustrated in Figure 15. As prices rise from lower-limit to upper-limit levels, there is a sharp increase in government revenues. The degree of expansion in taxes is inversely related to the before-tax profitabilities of the uranium projects. For the high-grade unconformity project, the most profitable opportunity, taxes rise five-fold (from $1,307 million to $6,329 million) as prices are increased through the lower- to upper-limit range. In the case of the quartz-pebble conglomerate project, the most marginal situation, taxes increase by about a factor of 13 (from $202 million to $2,707 million) over the same price range.

Figure 15. Government tax revenues in Saskatchewan as a function of market price

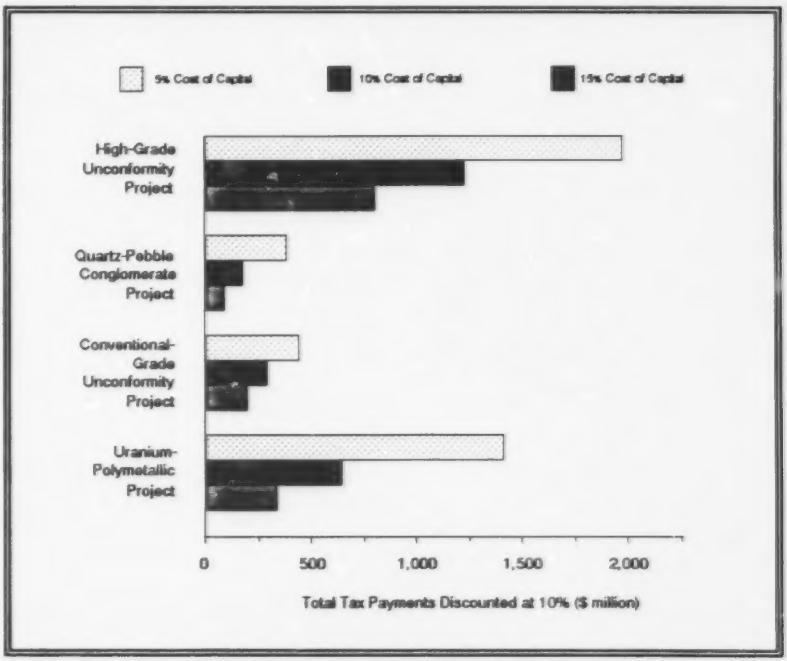


Cost-of-Capital Variants

Government tax revenues, time-adjusted to the start of development, are also sensitive to the discount rate applied as shown in Figure 16 for the tax and uranium royalty policies operative in Saskatchewan. As the discount rate is increased from 5 percent to 15 percent, the time-adjusted taxes are shown to decrease:

- by a factor of between four and five for the uranium-polymetallic and quartz-pebble conglomerate projects; and
- by a factor of between two and three for the high- and conventional-grade unconformity projects.

Figure 16. Government tax revenues in Saskatchewan as a function of the cost of capital



Uneconomic Uranium Project Situations

The before- and after-tax project evaluation results summarized in Chapters 5 and 6 highlighted several circumstances under which one or more of the representative uranium projects would be uneconomic to develop. The government tax revenues presented in this chapter and in Appendix VI include both economic and uneconomic situations.

Three taxation criteria, derived from the tax assessments summarized here, are presented in Chapters 8 to 10 and Appendices VII to IX. In these subsequent appraisals, it is considered appropriate to restrict attention only to those project situations which would be economic on an after-tax basis. After all, these are the only circumstances which would justify investment in mine development and the associated generation of taxable income.

Consequently, the following situations determined in Chapter 5 to be uneconomic on a before-tax basis are excluded from further consideration:

- quartz-pebble conglomerate project at lower-limit prices;
- uranium-polymetallic project at lower-limit prices;
- quartz-pebble conglomerate project at the 15-percent cost of capital.

Also, results for the following further circumstances found in Chapter 6 to be uneconomic as an outcome of taxation policies are not presented:

- conventional-grade unconformity project at lower-limit prices in all six jurisdictions;
- quartz-pebble conglomerate project at expected prices except in the Northwest Territories and Ontario;
- uranium-polymetallic project in Saskatchewan, the Northern Territory, South Australia, and Western Australia at the 15-percent cost of capital.

Summing Up

The government tax revenues which would be forthcoming from the uranium projects are substantial, even in discounted terms. There is a high degree of variability in tax revenues both among projects and across jurisdictions.

Generally, the taxation systems in Saskatchewan and the Northern Territory are shown to generate the most government revenue while the tax regimes in the Northwest Territories and Ontario produce the least amount

of taxes. These comparative findings are in keeping with the perceived profit-generating potential of known uranium deposits within these jurisdictions. Once again, South Australia and Western Australia are positioned between the extremes.

A sharp increase in government revenues takes place as market prices rise. The degree of expansion in taxes which occurs is found to be inversely related to the potential profitability of the projects. Tax revenues are also shown to be sensitive to the discount rate applied.

The government revenues summarized here are used in Chapters 8 to 10 to examine three further taxation criteria.

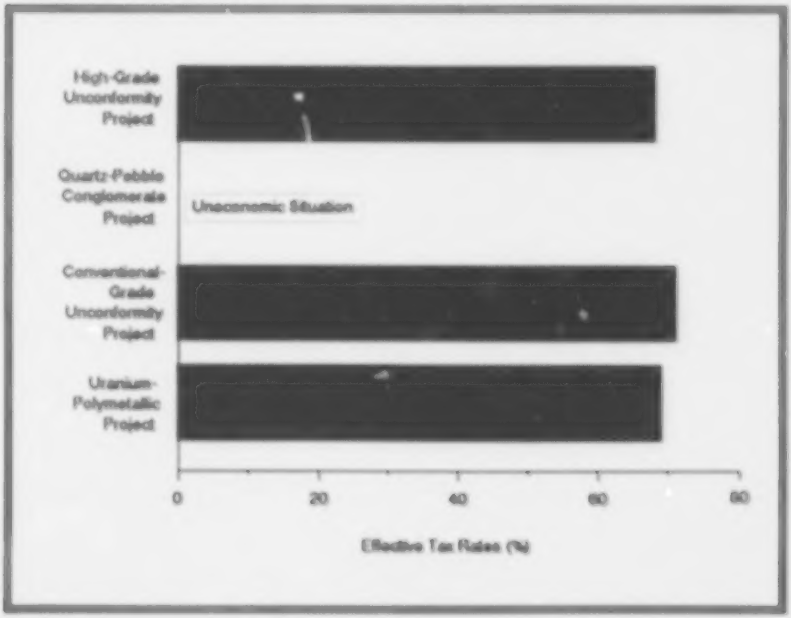
8. Effective Tax Rates

In this chapter, the impact of taxation on the economics of the uranium projects is measured by the "effective tax rate". For each economic project situation, the effective tax rate is defined as the discounted taxes divided by the before-tax net present value. Both the tax payments and the project cash flows are time-adjusted to the start of development by the cost-of-capital rate. A complete set of effective tax rate results can be found in Appendix VII.

Base Case Results

Effective tax rates for the four uranium projects under the Saskatchewan tax system are presented in Figure 17. The overall level of taxation is high, and

Figure 17. Effective tax rates under Saskatchewan base case conditions



does not change very much among the economic project situations, varying from 68 percent to 71 percent. The Saskatchewan uranium royalty is the single largest component, and combined Saskatchewan income tax and royalty payments account for about two thirds of the overall rate.

Results among Jurisdictions

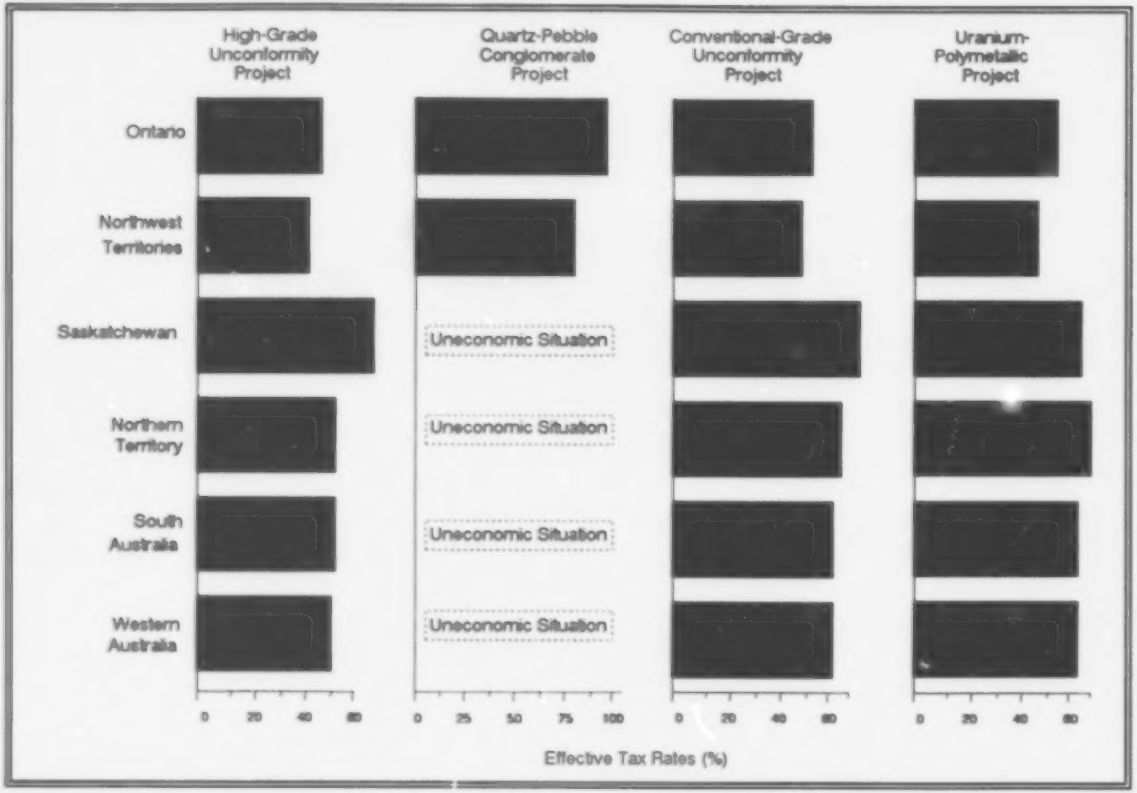
Comparative tax rate results for the six Canadian and Australian jurisdictions are illustrated in Figure 18. Generally, the effective tax rates in Saskatchewan and the Northern Territory are found to be significantly higher than for the other four systems. The range of overall tax rates is notable and can be summarized as follows:

- tax rates for the high-grade unconformity project vary from 43 percent in the Northwest Territories to 68 percent in Saskatchewan;
- the tax rates for the quartz-pebble conglomerate project are exceedingly high, 82 percent and 99 percent in the Northwest Territories and Ontario, respectively. In the other jurisdictions, the tax rate exceeds 100 percent, rendering this marginal but potentially economic project uneconomic on an after-tax basis;
- in the case of the conventional-grade unconformity project, the effective tax rates range from 49 percent in the Northwest Territories to 71 percent in Saskatchewan;
- for the uranium-polymetallic project, the tax rates vary from 51 percent in the Northwest Territories to 70 percent in the Northern Territory.

The range of tax rates for each project is much narrower in Australia than in Canada, varying as follows:

- from 50 percent (Western Australia) to 52 percent (Northern Territory and South Australia) for the high-grade unconformity project;
- from 62 percent (South Australia and Western Australia) to 66 percent (Northern Territory) in the case of the conventional-grade unconformity project;
- from 64 percent (South Australia and Western Australia) to 70 percent (Northern Territory) for the uranium-polymetallic project.

Figure 18. Effective tax rates among jurisdictions



The effective tax rates appear in most cases to be an inverse function of the before-tax profitability of the projects. In other words, the tax rates shown in Figure 18 are significantly lower for the high-grade unconformity project than for either the quartz-pebble conglomerate or uranium-polymetallic projects. Effective tax rates for the conventional-grade unconformity project tend to lie between the two extremes.

Basic differences in the tax rate components are apparent. The make-up of the overall rates presented here will be examined in Chapter 9.

Market Price Variants

Trends in the effective tax rate as a function of market price are shown in Figure 19 for Saskatchewan tax conditions.[17] Generally, the tax rates in Saskatchewan increase as a function of price. Thus, more profitable project situations which arise from more favourable market conditions are taxed at higher rates. As we will see later, this is a particular attribute of profitability-based taxation systems. This progressive tax feature is found in only two components of the tax regimes examined in this study:

- the graduated royalty provision in the Saskatchewan uranium royalty system;
- the surplus-related royalty provision in the Olympic Dam royalty regime in South Australia.

Thus, the direction of the tax rate trends illustrated in Figure 19 is unusual.

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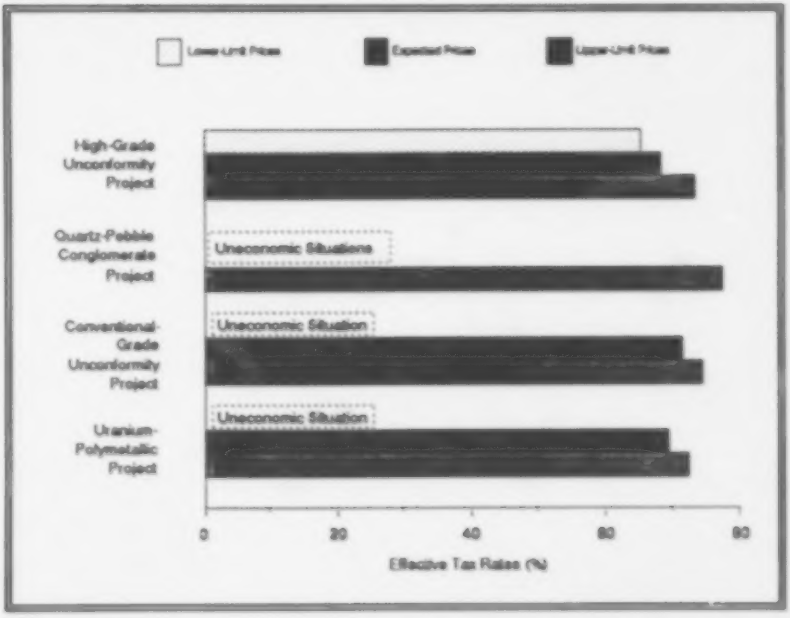
[17] Our model assumes constant prices over time at the expected, lower-limit, and upper-limit levels. One of the most distinguishing characteristics of mining is that mineral products, including uranium concentrate, are subject to significant price cycles. What effect do these short-term market fluctuations have on the after-tax viability of mining projects and effective tax rates? While we have not considered this important factor, other studies indicate that the associated variability in revenue tends to reduce after-tax investment incentive by raising the effective tax rate, especially for profit- and profitability-based tax systems which have graduated schedules. In general, the impact of price cycles is found to be relatively small compared with the sensitives to the long-term price level and cost of capital variants evaluated here. See Brewer, Bergevin and Dunlop; and Mackenzie and Bilodeau (1982).

Figure 19. Effective tax rates in Saskatchewan as a function of market price

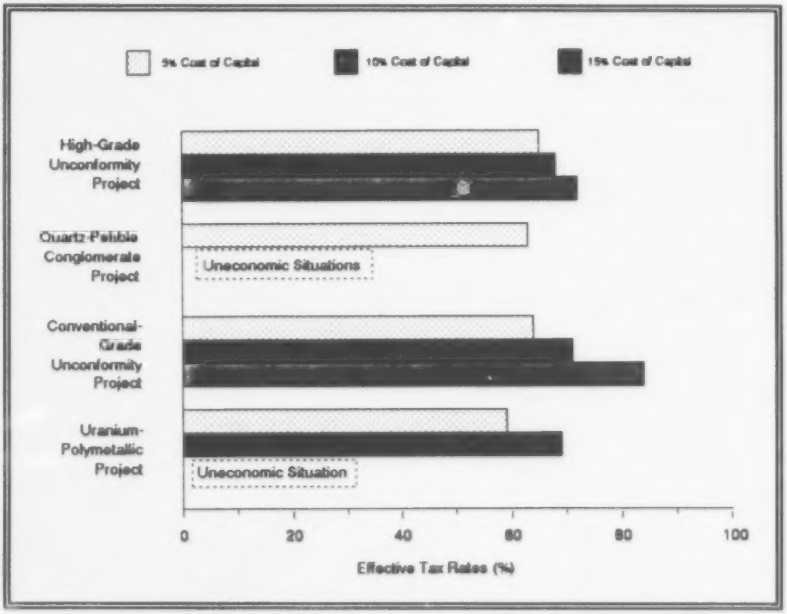


Cost-of-Capital Variants

The sensitivity of the effective tax rate to the cost of capital for Saskatchewan taxation policies is illustrated in Figure 20. There is a marked increase in the effective tax rate as a function of the cost of capital. As the discount rate is raised from 5 percent to 15 percent, the effective tax rates increase as follows:

- from 65 percent to 72 percent for the high-grade unconformity project;
- from 64 percent to 84 percent in the case of the conventional-grade unconformity project;
- from 59 percent to over 100 percent (denoted by the uneconomic situations) for the quartz-pebble conglomerate and uranium-polymetallic projects.

Figure 20. Effective tax rates in Saskatchewan as a function of the cost of capital



Thus, less profitable project circumstances arising from the imposition of higher costs of capital are taxed at higher rates. The explanation of this finding is as follows. Only two provisions in the tax systems analyzed – the graduated royalty and surplus-related royalty aspects of the Saskatchewan and South Australia systems, respectively – make allowance for the cost of capital. None of them, as considered here, adjusts for real constant dollar variations in the cost of capital.[18] As the cost of capital rate is increased, from 5 percent to 15 percent in this instance, the before-tax net present value for each project is reduced more than the corresponding decrease in discounted tax payments. Thus, the effective tax rate rises.

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[18] With respect to the Saskatchewan and South Australia royalty regimes, this is a moot point. The cost of capital is unlikely to vary from 5 to 15 percent without some corresponding change in the "prime rate" in Saskatchewan and the "10-year bond rate" in South Australia. Thus, these royalty systems will likely be somewhat sensitive to changes in the cost of capital. This effect is not considered in the study.

Effective Tax Rates as a Function of Profitability

This section further examines the relationship between effective tax rates and project profitability. To do this, tax rate results are presented in order of the before-tax profitability of the respective project situations defined on the basis of rate of return. Variations in profitability arising from both project-specific characteristics and market prices are considered. To help understand this relationship, effective tax rates are analyzed for the individual components of each tax system.

Results for the Canadian and Australian income tax systems are presented in Table 9. Note that the uranium projects have been rearranged from left to right in order of increasing profitability. Generally, the effective income tax rates are shown to decrease as a function of profitability.

Table 10 shows effective tax rates for the provincial mining tax and royalty systems analyzed. Under the Ontario and Northwest Territories regimes, tax rates are once again found to decrease as project profitability rises. In the case of the Saskatchewan uranium royalty system, however, tax rates are shown to increase with profitability.

Results for the state royalty regimes in Australia are given in Table 11. In all cases, the effective tax rates decrease as a function of before-tax profitability. However, the reduction in tax rates is much less pronounced in South Australia than in the Northern Territory and Western Australia.

In summary, the Saskatchewan uranium royalty system is the only "progressive" tax system analyzed, taking an increasing proportion of the before-tax net present value as profitability rises. All of the other systems considered are "regressive", with tax rates decreasing as a function of profitability as illustrated in Tables 9 to 11.

These empirical trends are explained by the underlying structure of the various tax regimes, as outlined in Chapter 3 and summarized in Table 5.

Revenue-based taxation is particularly regressive. The amount of tax collected represents a fixed "off-the-top" burden, unrelated to either profit or profitability. Thus, as profitability rises, this fixed burden represents a decreasing share of before-tax net present value. This form of taxation has greatest impact in terms of effective rates at the investment margin. The revenue-based tax components in this study include the Northern Territory and Western Australia royalties, the *ad valorem* provision in the Olympic Dam royalty in South Australia, and the basic royalty constituent of the Saskatchewan uranium royalty.

Table 9. Effective tax rates as a function of profitability: Canadian and Australian income tax systems (percent)

Tax Jurisdiction and Price Variant	Uranium Project			
	Quartz-Pebble Conglomerate	Uranium-Polymetallic	Conventional-Grade Unconformity	High-Grade Unconformity
Federal and Provincial Corporate Income Tax				
Lower-limit prices	..	..	..	40
Expected prices	..	42	40	35
Upper-limit prices	40	36	36	34
Commonwealth Corporate Income Tax				
Lower-limit prices	..	..	..	47
Expected prices	..	47	48	40
Upper-limit prices	46	41	42	39

.. uneconomic situation

Note: income tax rates are based on conditions in Saskatchewan for Canada, and in the Northern Territory for Australia

Table 10. Effective tax rates as a function of profitability: provincial mining tax and royalty systems in Canada (percent)

Tax Jurisdiction and Price Variant	Uranium Project			
	Quartz-Pebble Conglomerate	Uranium-Polymetallic	Conventional-Grade Unconformity	High-Grade Unconformity
Ontario Mining Tax				
Lower-limit prices	..	..	..	15
Expected prices	29	17	13	13
Upper-limit prices	16	14	11	12
Northwest Territories Mining Tax				
Lower-limit prices	..	..	..	13
Expected prices	19	14	13	11
Upper-limit prices	13	12	11	11
Saskatchewan Uranium Royalty				
Lower-limit prices	..	..	..	25
Expected prices	..	27	31	33
Upper-limit prices	37	36	38	39

.. uneconomic situation

Table 11. Effective tax rates as a function of profitability: state royalty systems in Australia (percent)

Tax Jurisdiction and Price Variant	Uranium Project			
	Quartz-Pebble Conglomerate	Uranium-Polymetallic	Conventional-Grade Unconformity	High-Grade Unconformity
Northern Territory Royalty				
Lower-limit prices	..	..	..	21
Expected prices	..	23	18	12
Upper-limit prices	17	12	11	9
South Australia Royalty				
Lower-limit prices	..	..	..	11
Expected prices	..	13	11	11
Upper-limit prices	12	11	11	11
Western Australia Royalty				
Lower-limit prices	..	..	..	11
Expected prices	..	12	11	8
Upper-limit prices	11	7	8	6

.. uneconomic situation

Profit-based taxation is also regressive. This is mainly because the determination of taxable income makes no allowance for the mining company's cost of capital. Thus, as project profitability decreases towards the cost-of-capital threshold, the tax revenues collected represent an increasing share of the before-tax net present value remaining above the investment margin. Conversely, tax rates decrease as profitability rises. This explains the regressive results presented for federal and provincial income taxes in Canada, commonwealth income tax in Australia, and mining taxes in Ontario and the Northwest Territories.

Profitability-based taxation is the only type which is by design of a progressive nature. With this form of taxation, no tax is levied below a specified threshold rate of return which, from an efficiency point of view, should approximate the mining company's cost of capital. Above this threshold value, the tax rate increases to a designated maximum marginal rate for highly profitable projects. Thus, the effective tax rate varies as a direct function of project profitability, tending towards zero as the investment margin is approached. The graduated royalty provision in the Saskatchewan uranium system and the surplus-related aspect of the Olympic Dam royalty in South Australia are examples of the profitability-based structure of taxation.

The progressive tax rate results shown in Table 11 for the Saskatchewan royalty system arise because the profitability-based aspect is larger and, therefore, outweighs the revenue-based provision. On the other hand, in South Australia, the revenue-based provision in the Olympic Dam system outweighs the profitability-based aspect, at least for the range of project conditions examined.

Summing Up

The effective tax rate criterion provides a clear indication of the burden of taxes imposed on the representative uranium projects. Rates of taxation are shown to characteristically range from 50 to 60 percent. However, the rates are also highly variable. For expected value conditions, tax rates for the three projects which are generally economic range as follows:

- 43-51 percent in the Northwest Territories;
- 48-59 percent in Ontario;
- 50-64 percent in Western Australia;
- 52-64 percent in South Australia;
- 52-70 percent in the Northern Territory;
- 68-71 percent in Saskatchewan.

The relationship between effective tax rates and project profitability has been examined. The Saskatchewan uranium royalty system is found to be the only "progressive" system evaluated, taking an increasing proportion of before-tax net present value as project profitability rises. All of the other systems analyzed are "regressive", the burden of taxation decreasing as a function of profitability. Revenue-based taxation is particularly regressive, having greatest impact at the investment margin. State royalty systems in Australia typically are of this type.[19]

Earlier chapters have highlighted several similarities between Saskatchewan and the Northern Territory of Australia. Both are important uranium producers, and both offer excellent geological potential for future discovery and development. Saskatchewan has the highest level of taxation in Canada for uranium mining. Likewise, uranium mining in the Northern Territory bears the greatest tax incidence in Australia. However, as illustrated here by our project model "measuring sticks", the structure of their respective taxation systems represents opposite extremes.

Industry and government have a common interest in maximizing the economic benefits generated by the mineral sector. A progressive profitability-based structure of taxation is the only one which, at least theoretically, enables the full potential value of mining to be realized. For this reason, it is hard to understand why this type of tax system is the exception rather than the rule and why, on the other hand, regressive systems of taxation remain so prevalent.

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[19] The draft report of the Australian government's Industry Commission for its inquiry into the mining and minerals processing industries in Australia is particularly critical of the inefficiency and economic distortion associated with existing revenue-based state royalty arrangements. The Commission recommends movement towards profitability-based royalty schemes with anticipated efficiency gains which, in the Commission's view, will exceed any potential increase in administration and compliance costs. See *Mining and Minerals Processing in Australia*, draft report, Industry Commission, Canberra, September 1990.

9. Intergovernmental Tax Shares

The sharing of government tax revenues is examined in this chapter. Tax payments, time-adjusted to the start of development at the cost-of-capital rate, provide the basis for determining this division. The tax shares are determined in the following two ways:

- *by level of government* - federal or commonwealth taxes vs. provincial, territorial or state taxes or royalties;
- *by type of tax payment* - income taxes vs. mining taxes or royalties.

A complete set of numerical results is tabled in Appendix VIII.

Base Case Results

Intergovernmental tax shares for base case project conditions and the Saskatchewan tax system are illustrated in Figure 21 by level of government. Provincial government revenues from income tax and royalty payments account for 60-65 percent of total taxes. The balance of 35-40 percent constitutes federal government revenues.

Figure 22 portrays the division of tax revenues by type of payment. Income taxes are found to represent 52-61 percent of the total for these base case conditions, while royalty payments take up the remaining 39-48 percent.

Results among Jurisdictions

Figure 23 shows intergovernmental tax shares by level of government for the six Canadian and Australian taxation systems evaluated. There is clearly a fundamental difference in sharing arrangements between the two countries. Federal government revenues in Canada account for 35-57 percent of the total while, in Australia, payments to the commonwealth government represent 67-85 percent of total taxes. Conversely, revenues derived by the Canadian prov-

Figure 21. Tax shares by level of government under Saskatchewan base case conditions

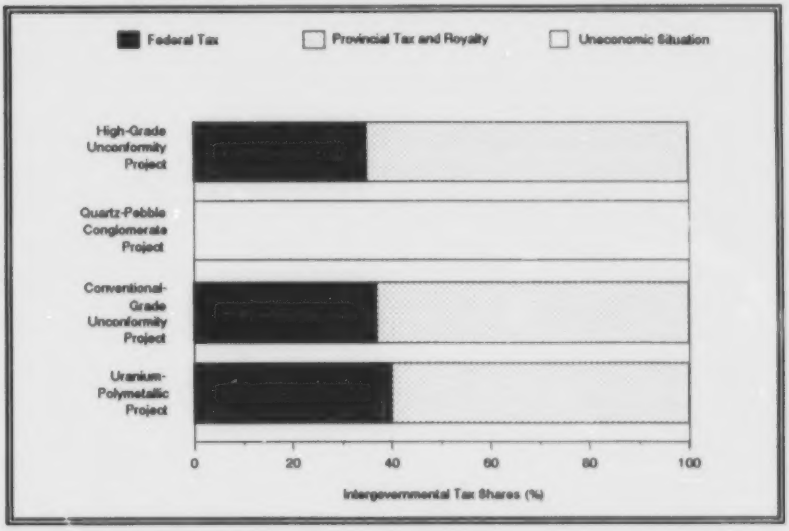


Figure 22. Tax shares by type of payment under Saskatchewan base case conditions

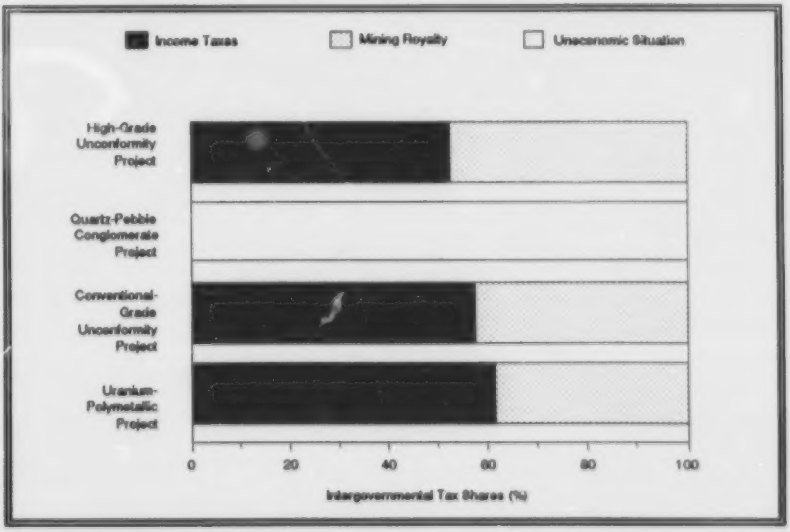
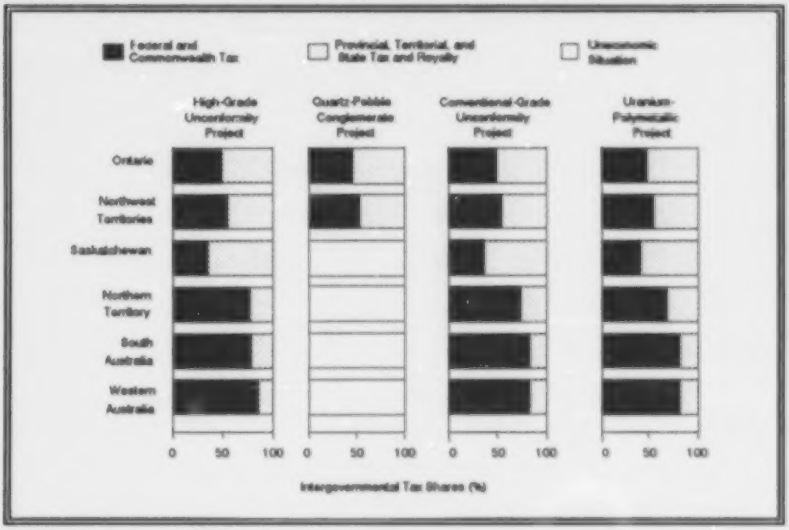


Figure 23. Tax shares by level of government among jurisdictions



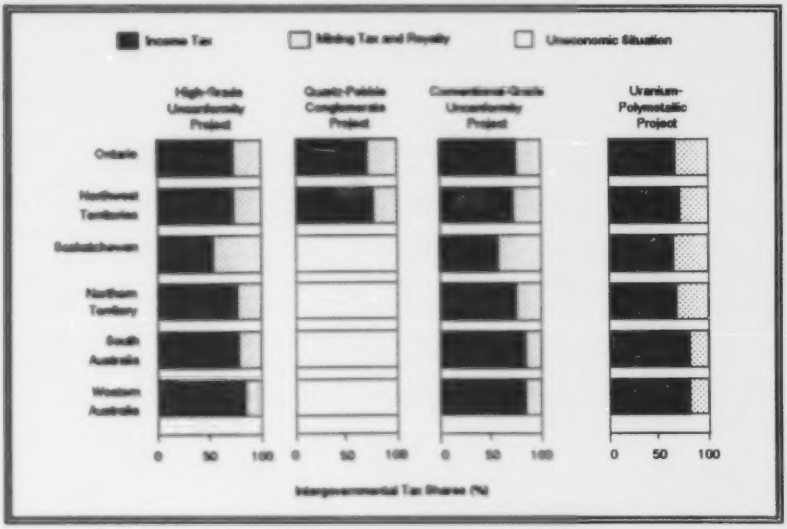
inces make up 43-65 percent of the total, while the state governments in Australia only receive a 15-33 percent share.

Within Canada, there is a marked difference in the sharing of tax revenues in the Northwest Territories and Ontario on the one hand and in Saskatchewan on the other. In the first two cases, the federal government receives 47-57 percent of total revenues, as compared to only 35-40 percent in Saskatchewan. Differences in government revenue shares among the three Australian jurisdictions are less pronounced. The Northern Territory share is found, in most cases, to be significantly higher than in South Australia and Western Australia.

Intergovernmental tax shares by type of payment are illustrated in Figure 24. The shares for the Australian cases are identical with those presented in Figure 23 by level of government. Income taxes in Canada are found to account for 52-76 percent of total government revenues, compared to 77-88 percent in Australia. Conversely, mining taxes and royalties make up the balance of 24-48 percent in Canada, as compared to a 15-33 percent share for royalties in Australia.

Once again, a sharp difference in the division of tax revenues is evident in Figure 24 among the Canadian jurisdictions. While income taxes comprise 70-76 percent of total taxes in the Northwest Territories and Ontario, they represent only 52-61 percent of total government revenues in Saskatchewan.

Figure 24. Tax shares by type of payment among jurisdictions

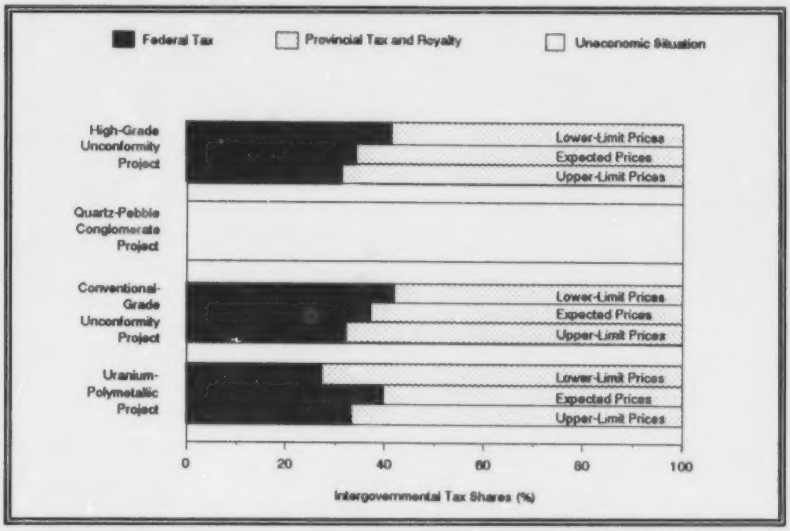


Therefore, in the first two cases, mining taxes account for only 24-30 percent of total taxes, as compared to 39-48 percent under the Saskatchewan uranium royalty system.

Market Price Variants

Figure 25 portrays intergovernmental tax shares by level of government as a function of market price for base case conditions in Saskatchewan. There is a significant decrease in the federal government share, and a corresponding increase in the provincial government share, as prices rise. For example, in the case of the high-grade unconformity project, as prices are increased from lower- to upper-limit levels, the federal share declines from 41 to 31 percent, and the Saskatchewan government share increases from 59 to 69 percent. These changes in the division of government revenue are mainly attributable to the progressive structure of the graduated royalty provision in the province's uranium royalty system combined with the regressive nature of the federal tax system.

Figure 25. Tax shares by level of government in Saskatchewan as a function of market price



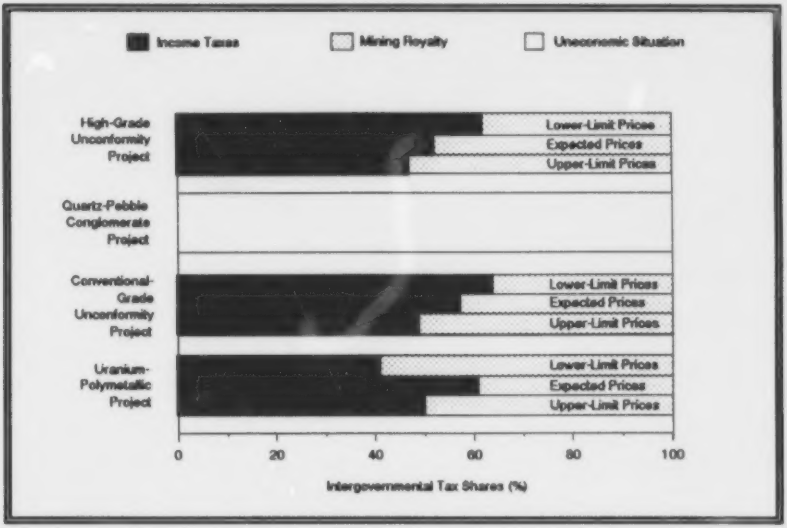
Similarly, tax shares by type of payment are shown in Figure 26. In general, the income tax share decreases and the royalty share increases as a function of market price. Once again using the example of the high-grade unconformity project, the income tax share decreases from 62 to 47 percent, and the royalty share correspondingly increases from 38 to 53 percent, as prices are increased through the specified range. The reason for the changing division of government tax revenues is the same as given above for the sharing trend between levels of government, namely the progressive feature of the Saskatchewan uranium royalty in combination with the regressive structure of federal and provincial income taxes.

Summing Up

A salient feature of Canadian and Australian tax policy concerns how government tax revenues are divided.

Despite the similarities in constitutional history and political relationships between levels of government in the two countries, fundamental differences in the sharing of tax revenues are evident. To illustrate with expected price and cost-of-capital conditions, the federal government share in Canada is

Figure 26. Tax shares by type of payment in Saskatchewan as a function of market price



found to be 35-57 percent as compared to 67-85 percent for the commonwealth government in Australia. Conversely, the provincial share of government tax revenues in Canada is much larger (43-65 percent) than the state governments' share in Australia (15-33 percent).

There is also a marked difference between Canada and Australia when the division of tax revenues is analyzed by type of payment. For expected conditions, income taxes in Canada account for 52-76 percent of government tax revenues as compared to 67-85 percent in Australia. Conversely, the mining tax and royalty component is substantially larger in Canada (24-48 percent) than in Australia (15-33 percent).

Within Canada, both the provincial government share and the mining tax and royalty share of total tax revenues are found to be much higher in Saskatchewan than in Ontario and the Northwest Territories. The marked differences are attributable to the relatively high level of tax associated with the Saskatchewan uranium royalty. These gaps widen as a function of project profitability, a consequence of the progressive structure of the Saskatchewan uranium royalty in combination with the regressive nature of the federal and other provincial systems. The opposite tendency is evident in Australia, the disparity in tax shares between the regressive Northern Territory system and the more progressive South Australia royalty closing with increasingly profitable project situations.

10. Comparative Levels of Taxation

In order to directly address the competitive position issue, this chapter compares the incidence of taxation in the various Canadian and Australian jurisdictions. Once again, these comparative tax levels are based on tax payments time-adjusted at the cost-of-capital rate to the start of development. For comparative purposes, government tax revenues in Saskatchewan are assigned an index of 100.

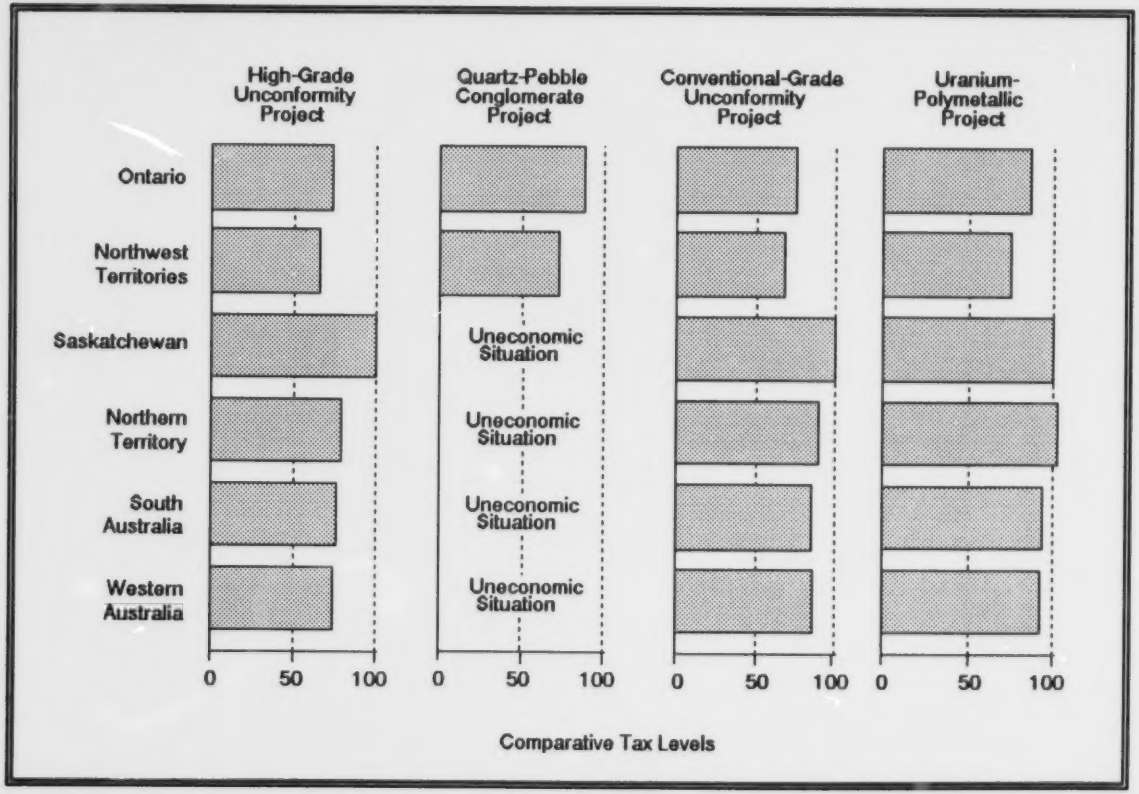
A complete set of results for comparative levels of taxation can be found in Appendix IX.

Results among Jurisdictions

Comparative tax levels among the Canadian and Australian jurisdictions for expected market prices and the 10-percent cost of capital are illustrated in Figure 27. The overall level of taxation in Saskatchewan is shown to be in most cases substantially higher than for the other regimes. The comparative tax level for the Northern Territory marginally exceeds that of Saskatchewan in the uranium-polymetallic case and otherwise comes in second. Taxes collected represent

- between 63 and 78 percent of Saskatchewan tax revenues in the case of the high-grade unconformity project;
- 72-87 percent of the base case level for the two quartz-pebble conglomerate project situations which are economically viable;
- from 68 to 92 percent of Saskatchewan taxes in the case of the conventional-grade unconformity project;
- 74-101 percent of the base case level for the uranium-polymetallic project.

Figure 27. Comparative tax levels among jurisdictions



The level of taxation in Saskatchewan is relatively burdensome, mainly because of the high rates incorporated in the provincial uranium royalty. The gap between Saskatchewan and the other regimes widens as a function of profitability, being greatest for the high-grade unconformity project. Once again, this tendency is attributable to the progressive feature of the Saskatchewan royalty in combination with the typically regressive nature of the other tax systems.

Otherwise, as shown in Figure 27, the taxation systems in Ontario, and particularly in the Northwest Territories, characteristically offer a competitive advantage in relation to the Australian jurisdictions.

Market Price Variants

The sensitivity of comparative tax levels to future market price possibilities is presented in Figure 28. As prices rise, the competitiveness of all other jurisdictions is enhanced relative to Saskatchewan. Also, the Australian jurisdictions typically become more competitive relative to Ontario and the Northwest Territories.

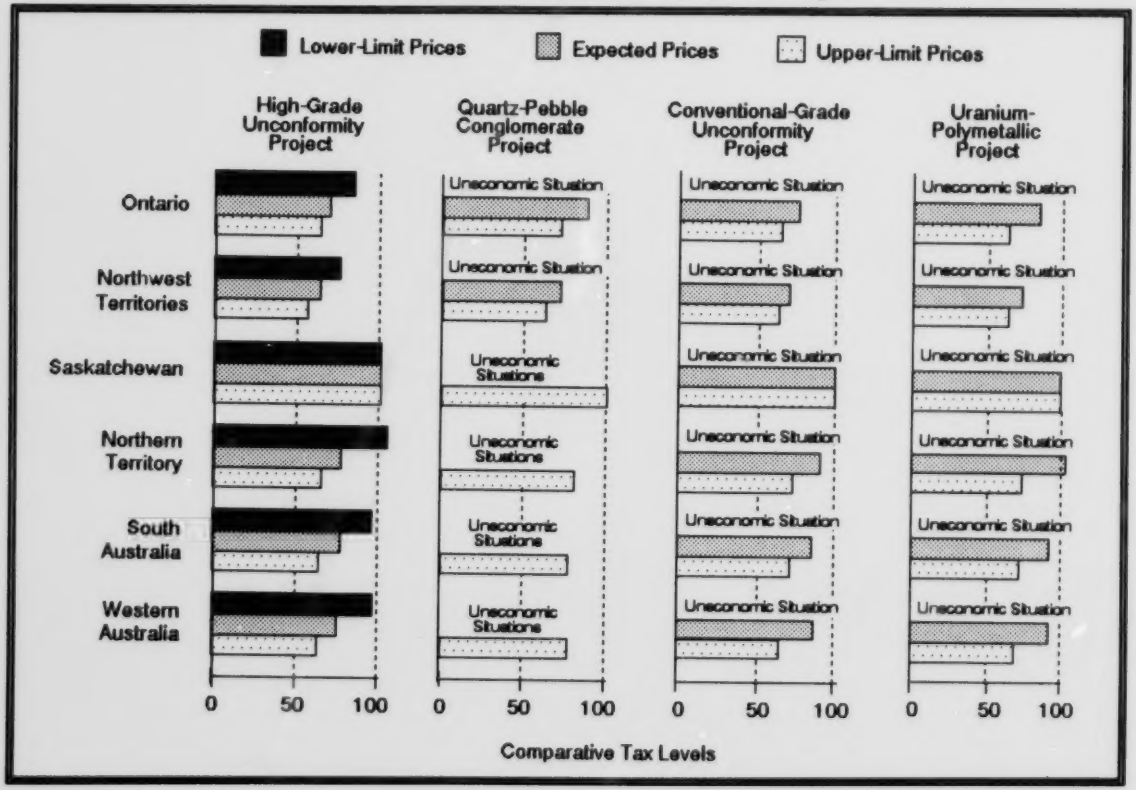
Taxation Systems of Secondary Interest

The taxation system of secondary interest to the study are

- the old uranium royalty regime in Saskatchewan;
- the Saskatchewan metallic minerals royalty, applicable to base metals and gold;
- the Queensland royalty system;
- the general royalty operative in South Australia outside the Olympic Dam mining lease.

A complete set of results for each of these systems is included in Appendices V to IX.

Figure 28. Comparative tax levels among jurisdictions as a function of market price



Saskatchewan Systems

Comparative levels of taxation for the three Saskatchewan systems are presented in Figure 29 as a function of market price. Generally, the old and new uranium royalty systems result in similar tax levels. Because the old royalty regime has a relatively small revenue-based component (Table 5), it provides more relief at the investment margin. Conversely, the comparative tax level tends to increase as a function of both project profitability and market price.

The level of taxation associated with the Saskatchewan metallic minerals royalty, on the other hand, is shown in Figure 25 to typically account for only about 80 percent of the taxes raised by the uranium royalty systems. In terms of competitive position, the metallic minerals royalty system is more or less on a par with taxation in Ontario (Figures 23 and 24). Because of the regressive structure of this system, the comparative tax level decreases significantly as a function of project profitability and market price.

Queensland System

Apart from the general royalty regime in South Australia, the Queensland taxation system is found to be the most competitive in Australia. Under base case conditions, the level of taxation in Queensland is somewhat higher than for Ontario, collecting between 72 and 87 percent of Saskatchewan tax revenues.

South Australia Systems

Comparative levels of taxation for the two systems operative in South Australia are illustrated in Figure 30 in relation to the Saskatchewan base. The overall tax level associated with the general state royalty is found to be about 5 percent lower than that connected with the Olympic Dam scheme. Under this general system, South Australia's competitive position would move up from near the bottom to the top of the Australian range. Since the general state royalty is entirely revenue-based, the comparative tax level decreases as project profitabilities and market prices rise.

Figure 29. Comparative tax levels for Saskatchewan systems of secondary interest as a function of market price

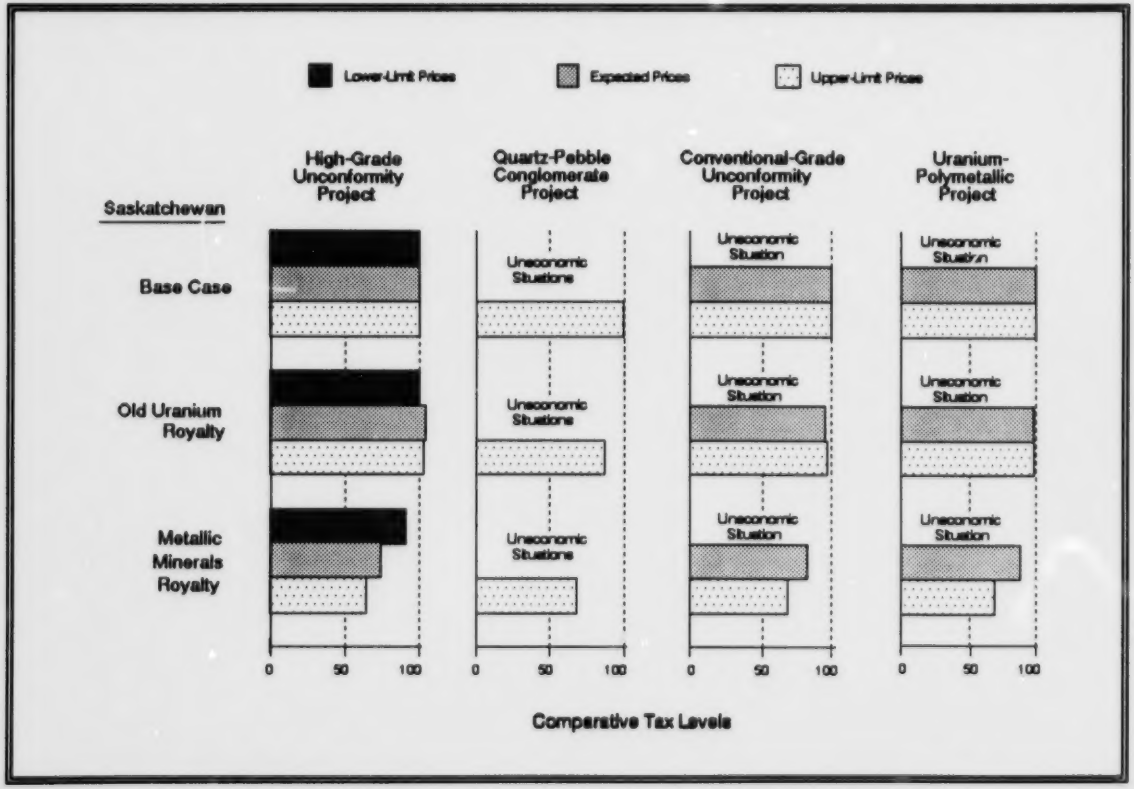
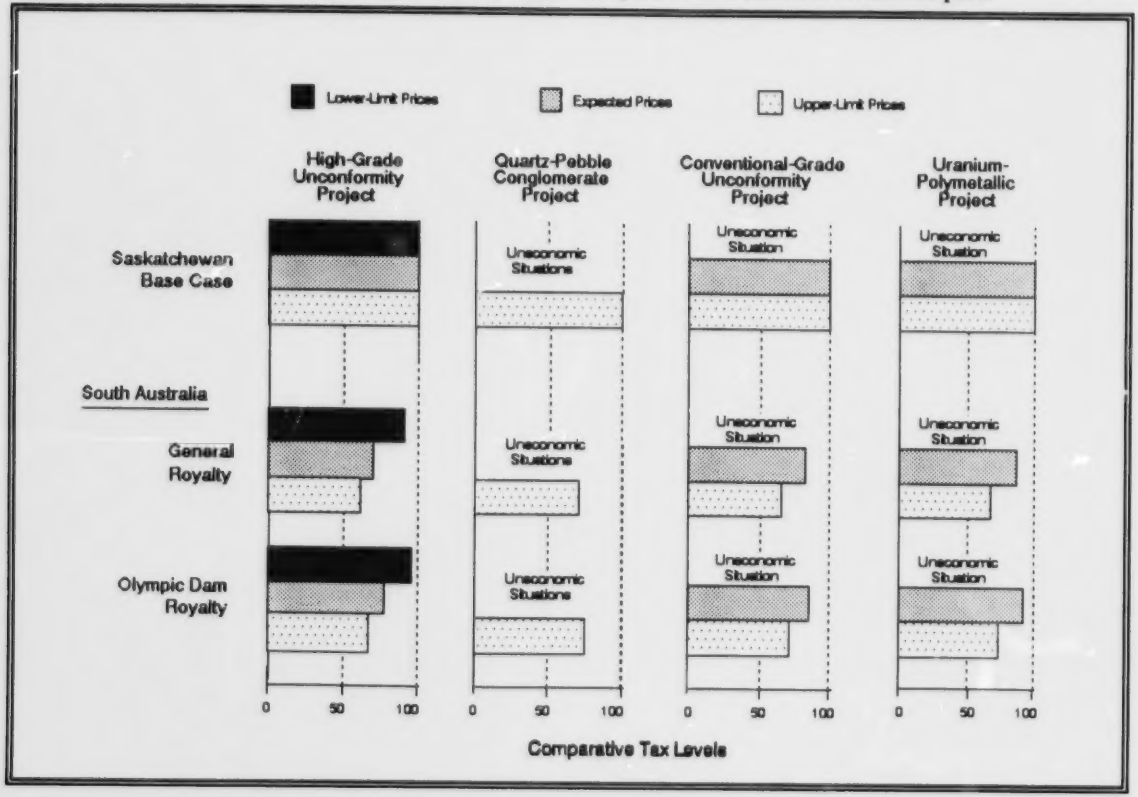


Figure 30. Comparative tax levels for the South Australia systems as a function of market price



Summing Up

Comparative tax levels for the uranium projects in Saskatchewan are found in most cases to be in the order of 10 to 25 percent higher than in the other five jurisdictions analyzed. In this respect, Saskatchewan's competitive tax position stands out as being the least favourable. The level of taxation in the Northern Territory characteristically comes in second, in some instances rivalling and marginally exceeding Saskatchewan. South Australia and Western Australia once more stand towards the middle of the competitive tax range.

Otherwise, inequalities in taxation policies, while certainly significant, are not as substantial. The Northwest Territories competitive tax position ranks as the most favourable, followed by Ontario.

In general, the new uranium royalty regime in Saskatchewan, introduced in 1990, is found to result in about the same level of taxation as the old system. However, the incidence of the new regime with respect to project profitability and market price is not as pronounced because it includes a significantly higher revenue-based component.

An examination of comparative tax levels and competitive position *by level of government* and *by type of payment*, not undertaken here, would be helpful in explaining the overall rankings which have been highlighted.

Competitive position has a number of facets. Only the taxation component is addressed in this study. No account is taken of the differences in geological potential, economic conditions, and other aspects of government policy which undoubtedly exist among the Canadian and Australian jurisdictions analyzed.

11. Conclusion

Canada and Australia are major players in the world's uranium industry and principal competitors for the uranium export market. The objective of the study is to compare the impact of taxation on the economic viability and competitive position of uranium mining in the two countries.

The evaluation is based on four types of uranium deposit which are of primary economic interest in Canada and Australia:

- high-grade unconformity;
- quartz-pebble conglomerate;
- conventional-grade unconformity;
- uranium-polymetallic.

Four hypothetical project models were developed for evaluation, based on these deposit types. The profiles have been synthesized from actual situations in order to provide realistic representations of the deposit types.

It has been assumed that the representative uranium deposits have already been discovered and delineated and are being considered for development. The four case studies have been designed in a way which makes them most suitable for the tax analysis to be carried out. Thus, for anticipated future conditions, the intention has been to make all of the projects economic on a before-tax basis, varying their expected returns from marginally economic to highly profitable. In order to achieve the desired make-up, the project models tend to portray superior examples of the respective deposit types in terms of ore reserve size and grade, and capital and operating costs.

The four uranium mining projects are initially appraised on a before-tax basis and then subjected to taxation. The following six taxation jurisdictions, three in Canada and three in Australia, are selected for primary attention on the basis of representing geologically prospective environments for the types of deposit being evaluated:

- Ontario;
- Northwest Territories;
- Saskatchewan;

- Northern Territory;
- South Australia;
- Western Australia.

The base case conditions, which are used as a standard of comparison with other results, include an "expected" uranium price of US$30 per pound of U_3O_8 and a 10-percent cost of capital. Market price and cost of capital are considered as the two principal variants for sensitivity analysis.

Several economic indicators are used to measure the attractiveness of the four uranium projects from a mining company perspective, including total sales revenue, rate of return, and net present value. Similarly, several taxation criteria are assessed from a government policy viewpoint – undiscounted and discounted tax revenues, effective tax rates, intergovernmental tax shares, and comparative tax levels.

All four of the uranium projects are large. Under expected price conditions, total sales revenue varies from $2.0 billion for the conventional-grade unconformity project to $12.8 billion for the uranium-polymetallic project.[20] Before-tax rates of return range from 14 percent for the quartz-pebble conglomerate model to 45 percent for the high-grade unconformity case. The potential net present values at 10 percent vary from $151 million for the quartz-pebble conglomerate project to $1,817 million in the case of the high-grade unconformity opportunity.

The taxation policies in the Northwest Territories are found to provide the greatest incentive for investment while those in Saskatchewan and the Northern Territory are found to be the least favourable. Taxation in Ontario tends to offer much more encouragement for investment than South Australia and Western Australia. These comparative results suggest that the Saskatchewan and Northern Territory taxation systems have been designed for the relatively profitable unconformity-related uranium deposits which have been discovered and developed in these jurisdictions.

Tax revenues from the four uranium projects analyzed are substantial. Expressing discounted tax revenues as a percentage of the potential before-tax net present values for each case, effective tax rates are found to be both high and variable, ranging as follows for expected price and cost-of-capital conditions:

- 43-51 percent in the Northwest Territories;
- 48-59 percent in Ontario;
- 50-64 percent in Western Australia;
- 52-64 percent in South Australia;

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[20] Money values are expressed in constant 1990 Canadian dollars.

- 52-70 percent in the Northern Territory;
- 68-71 percent in Saskatchewan.

The Saskatchewan uranium royalty system is shown to be the only "progressive" regime evaluated, capturing an increasing proportion of before-tax net present value as project profitability rises. Conversely, the Saskatchewan system is found to provide more incentive at the investment margin. This illustrates a competitive advantage associated with the progressive tax structure which is of particular importance in the context of the current depressed uranium price situation.

All of the other taxation systems analyzed are "regressive", the burden of taxation being greatest at the investment margin, and then decreasing as a function of profitability. Revenue-based taxation, a prominent feature of the Northern Territory and Western Australia regimes, has particularly distorting effects on investment.

Despite Canada-Australia parallels in constitutional history and political relationships between levels of government, fundamental differences in the sharing of tax revenues are evident. The federal government share of taxes in Australia is much higher than in Canada, 67-85 percent under expected future conditions as compared to 35-57 percent. Conversely, the provincial component of government tax revenues in Canada is much larger than the state governments' share in Australia. There is also a marked difference in the division of tax revenues by type of payment. For anticipated conditions, income taxes in Canada account for 52-76 percent of total government revenue as compared to 67-85 percent in Australia. Conversely, the mining tax and royalty component in Canada is relatively large.

The tax levels associated with the uranium projects, when hypothetically located in Saskatchewan, are found in most cases to be in the order of 10-25 percent higher than in the other five jurisdictions analyzed. Thus, Saskatchewan's competitive tax position stands out as being the least favourable. The level of taxation in the Northern Territory characteristically comes in second, in some instances rivalling and marginally exceeding Saskatchewan. At the other end of the spectrum, the Northwest Territories competitive tax position ranks as the most favourable, followed by Ontario. The comparative tax levels for South Australia and Western Australia tend to rank towards the middle of the range.

The potential and after-tax project evaluation results highlight a number of circumstances under which the uranium projects would be uneconomic to develop. As price and cost of capital are varied on a before-tax basis, the following situations are found to be uneconomic:

- quartz-pebble conglomerate project at lower-limit prices;
- uranium-polymetallic project at lower-limit prices;

- quartz-pebble conglomerate project at the 15-percent cost of capital.

The following additional potentially economic circumstances are rendered uneconomic as the result of taxation policies:

- conventional-grade unconformity project at lower-limit prices in all six jurisdictions;

- quartz-pebble conglomerate project at expected prices except in the Northwest Territories and Ontario;

- uranium-polymetallic project in Saskatchewan, the Northern Territory, South Australia, and Western Australia at the 15-percent cost of capital.

The distorting effects of taxation on private-sector investment decisions, illustrated here, represent an important inefficiency of existing government policies. To the extent that taxation acts in this way, the actual value to be realized from the projects falls short of the potential value which exists. The wealth-creating, employment, income, and foreign exchange benefits associated with uranium mining are thereby diminished.

This brings us to an important concluding point of mutual interest to Australia and Canada. The projected market price conditions used in the evaluation are significantly above present-day spot prices, and would be viewed by some as being on the optimistic side of longer-term expectations. Also, the four project models which are used as "measuring sticks" by design comprise superior ore reserve and cost characteristics in order to give a good economic spread of before-tax returns. Even so, as price and cost of capital are varied, and the evaluations proceed from a before-tax to an after-tax basis, the project situations listed above become uneconomic to develop. Thus, the study demonstrates quite clearly that only the very best uranium mining projects have a chance of being developed under current market conditions, and even these can be rendered uneconomic by excessive taxation regimes. It follows that exceptionally good-quality targets will have to be identified to provide the economic justification for uranium exploration. These realities will likely restrict uranium exploration and development activities for some time, not an unexpected response to a market situation where low prices have been caused largely by excess supply.

Appendix I

Uranium Project Profiles

High-Grade Unconformity Project

Deposits of this type include Key Lake, Cigar Lake, Collins Bay, and Eagle Point in Saskatchewan and Nabarlek I and II in the Northern Territory.

The deposit is situated in a remote location requiring a "fly-in" work program.

Geological Setting

The deposit occurs in altered rocks at the intersection of a fault zone with the unconformity, which separates the overlying sandstones from the underlying metasedimentary rocks. The deposit exists at the base of the cover rocks and in the crystalline basement rocks. The host rocks are sandstone and metamorphic rocks altered by illitization, chloritization and kaolinization.

The mineralized zone extends over 1,200m, to a depth of 200m, with a width that varies from 15 to 50m. The principal ore mineral is pitchblende, with local grades in some cases approaching 25 percent U_3O_8, which is accompanied by nickel-cobalt arsenides.

Mining

The deposit is to be mined using the open-pit method, following conventional practice except for two factors:

1. A stripping ratio of 30:1 will be required to gain access to the ore.
2. The high radiation levels associated with the ore will require special safety precautions. All mining machinery is to be equipped with lead shielding and all service vehicles require air filtration.

Processing

The ore presents process complexities because of extreme grade variability, high mercury content, and the presence of graphite. Because of these complexities, additional processing stages will be required in order to obtain acceptable recoveries. The processing facilities have to be located within specially designed drainage systems to collect runoff and seepage. After crushing and grinding the ore, pressure oxygen leaching will be used, followed by two-stage solvent extraction. Uranium will be precipitated with aqueous ammonia, dried, crushed, and packed for shipment and sale in the form of yellowcake.

Recoverable Ore Reserves

3,500,000 tonnes averaging 2.45% U_3O_8

Capacity

250,000 tonnes of ore per year

Preproduction Period

3 years

Employment

About 350 persons will be employed during production. The deposit is situated in a remote location and, consequently, the employees will not have permanent homes at the project site. They will be airlifted to the mine on a 7-day "in" and 7-day "out" schedule. The employees will work 11-hour shifts for the seven days, with one half of the work force at the site at any one time.

Mill Recovery Factor

98%

Preproduction Capital Costs ($ million)

Mine development	168
Mine plant and equipment	84
Processing facilities	215
Infrastructure	132
Working capital	20
Total	619

Production Costs ($ per tonne of ore)

Mining	105
Milling	118
Overheads	82
Total	305

Quartz-Pebble Conglomerate Project

Examples of this type include Elliot Lake, Ontario; the McInnes Lake occurrence in the Northwest Territories; Mentheena Basin, Western Australia; and occurrences in the Northern Territory.

The deposit is well located with respect to established road, rail, power, housing and townsite facilities.

Geological Setting

Proterozoic conglomerate and associated clastic sedimentary rocks overlie the Archean basement rocks. The deposit occurs within pyritic quartz-pebble conglomerate beds at the base of the quartzites on the limb of a large folded structure.

A major feature of the deposit is the uniformity and continuity of the ore-bearing rocks. The average dip of the deposit is 10 degrees. The ore-bearing zone is 3 to 8m thick and extends to a depth of 400m. Uraninite and brannerite are the principal uranium ore minerals.

Mining

Primary access to the ore zone will be through two main vertical shafts located 700m apart. The mining operation will be developed "on reef" within the ore-bearing horizon. The ore is to be extracted using the room-and-pillar method.

Processing

The milling process to be employed is a hydrometallurgical acid leach and ion exchange circuit. Following crushing and grinding, the ore will be leached using sulphuric acid. Recovery of the uranium will be by ion exchange using ammonia hydroxide to precipitate the yellowcake.

Recoverable Ore Reserves

40,000,000 tonnes averaging 0.14% U_3O_8

Capacity

1,500,000 tonnes of ore per year

Preproduction Period

4 years

Employment

About 600 persons are to be employed during production. They will live in an existing community 20km from the minesite.

Mill Recovery Factor

94%

Preproduction Capital Costs ($ million)

Mine development	90
Mine plant and equipment	103
Processing facilities	258
Infrastructure	45
Working capital	17
Total	513

Production Costs ($ per tonne of ore)

Mining	35
Milling	12
Overheads	3
Total	50

Conventional-Grade Unconformity Project

Deposits of this type include Dominique-Peter (Cluff Mining), and Maurice Bay in Saskatchewan; Kiggavik, Northwest Territories; Ranger, Jabiluka I and II, and Koongarra in the Northern Territory; Kintyre, Western Australia; and the Sibley Basin, Ontario.

The deposit is situated in a remote location requiring a "fly-in" work program.

Geological Setting

The deposit comprises several ore zones which occur within crystalline basement rocks. Each zone is 200 to 400m long, 15 to 40m thick, and 20 to 60m wide. They extend to approximately 140m in depth. The main uranium minerals are pitchblende and coffinite.

Mining

Open pit mining will be utilized, applying conventional techniques. The average stripping ratio will be about 8:1. Following removal of up to 25 metres of unconsolidated overburden, the ore and waste will be drilled, blasted, loaded into trucks, and hauled from the pit.

Processing

The mill will employ a conventional acid leach and solvent extraction process. The relatively simple mineralogy of the ore will make it possible to obtain a high uranium recovery with low chemical usage and a straightforward process circuit.

Recoverable Ore Reserves

5,000,000 tonnes averaging 0.50% U_3O_8

Capacity

500,000 tonnes of ore per year

Preproduction Period

3 years

Employment

About 250 persons are to be employed during production. Due to the remote mine location, employees will be airlifted to the site on a 7-day "in" and 7-day "out" schedule. They will work 11-hour shifts for the seven days, with half the work force at the mine at any one time.

Mill Recovery Factor

96%

Preproduction Capital Costs ($ million)

Mine development	23
Mine plant and equipment	80
Processing facilities	137
Infrastructure	85
Working capital	15
Total	340

Production Costs ($ per tonne of ore)

Mining	24
Milling	26
Overheads	52
Total	102

Uranium-Polymetallic Project

Examples of this type include Olympic Dam, South Australia; Port Radium, and the Bear Province in the Northwest Territories; Wernecke, Yukon; Maureen, and Ben Lomond in Queensland; and Coronation Hill, Northern Territory.

The deposit is situated in a remote location. A town is to be established about 10km from the minesite to accommodate approximately 4,000 people.

Geological Setting

The uranium-copper-gold deposit occurs beneath flat-lying barren sedimentary rocks, ranging in thickness from 290 to 420m. The mineralization consists of a complex association of fine-grained copper sulphide minerals, uranium minerals, and gold, contained in a sequence of coarse-grained sedimentary

rocks more than 500m thick. Ore zones range from 10 to 150m in thickness, are usually flat-lying or gently dipping, have a wide areal extent, and occur throughout the area of mineralization.

Mining

Primary access to the ore will be through two vertical shafts situated 300m apart. A combination of open stoping and cut-and-fill mining methods will be employed. Generally, open stoping with back-fill will be used in ore zones thicker than 35m, with cut-and-fill mining employed for ore blocks between 10 and 35m thick.

Processing

The main components of the processing plant will be the concentrator and the flotation tailings circuit. Ore comminution and flotation in the concentrator will produce a sulphide concentrate containing most of the copper and gold. The concentrate is to be cleaned by means of a radionuclide removal circuit, resulting in a saleable copper-gold product. The flotation tailings will contain the bulk of the uranium. Tailings will be processed by atmospheric leaching, followed by countercurrent decantation, solvent extraction, stripping, precipitation, and calcining to recover the uranium as yellowcake.

Recoverable Ore Reserves

75,000,000 tonnes averaging 0.16% U_3O_8, 1.25% Cu, 3.0 gpt Au

Capacity

2,500,000 tonnes of ore per year

Preproduction Period

4 years

Employment

About 1,050 persons are to be employed during production. They will live in the new town which would be established.

Mill Recovery Factors

Uranium: 92%
Copper: 90%
Gold: 75%

Preproduction Capital Costs ($ million)

Mine development	112
Mine plant and equipment	128
Processing facilities	305
Infrastructure	286
Working capital	41
Total	872

Production Costs ($ per tonne of ore)

Mining	22
Milling	26
Overheads	22
Total	70

Appendix II

Canadian Taxation Systems

Federal Corporate Income Tax

This outline reflects important federal tax reform proposals which were enacted in September 1988. The rules apply from 1990.

Cash Flow Format

Revenue
Less: Operating Cost
Capital Cost Allowance
Interest Payments
Development Expenditure Allowance

If negative: Carried Loss

Revenue
Less: Operating Cost

Net Income before Allowances
Less: Capital Cost Allowance

Resource Profits
Less: Resource Allowance
Interest Payments
Exploration Expenditures
Development Expenditure Allowance

Income for Carried Loss
Less: Carried Loss (from X−1 or X+1)

Income for Federal Corporate Income Tax
Federal Corporate Income Tax Otherwise Payable
Less: Investment Tax Credit

Net Federal Corporate Income Tax Payable

Capital Cost Allowance: applied to mine plant and machinery, the mill facility, and infrastructure capital. The amount allowable must be reduced by the investment tax credit (see below).

The deduction permitted is 12.5 percent of the allowable capital cost in the year of expenditure and 25 percent per year thereafter on a declining balance basis. A company is entitled to claim any amount of capital cost allowance up to the maximum permitted.

Resource Allowance: 25 percent of resource profits.

In effect, the resource allowance reduces the effective federal rate of tax by one-quarter from 28 percent to 21 percent [28 percent – .25(28 percent)], but without reducing tax credits related to debt financing, exploration expenditures, and development expenditures.

Interest Payments: deductible in the year incurred to the extent of corporate income from any source. Any balance not currently deductible can be carried back three years or forward indefinitely for deduction in future years.

Exploration Expenditures: cannot be used to increase a loss. They are deductible in a given year only if there is a positive income (i.e. a positive difference between revenue and all other deductions and allowances).

Development Expenditure Allowance: applies to the cost of mine shafts, declines, main haulage ways, and similar underground work undertaken before and after the start-up of production, and to waste stripping costs incurred prior to commencement of commercial production.[21]

These expenditures are deducted at up to 30 percent per year on a declining balance basis. The deduction may be claimed whether or not the corporation has income. In other words, the development expenditure allowance can be used to create a carried loss.

The acquisition costs of Canadian resource properties are also eligible for the development expenditure allowance. Similarly, when a company disposes of a Canadian resource property, the proceeds are applied to reduce the balance available for determining this allowance. If the balance becomes "negative", this amount is included in income.

Carried Loss: losses can be carried forward seven years and back three years.

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[21] Overburden removal costs after the start of production are treated as current operating costs.

Federal Corporate Income Tax: the net rate of corporate federal tax applicable to taxable income is 28 percent, computed as follows:

Basic rate	38%
Provincial abatement	(10)%
Net federal tax rate	28%

The 10 percent abatement of federal tax is designed to allow the provinces and territories room to impose corporate income taxes.

There is also a 3 percent federal surtax which was to be eliminated once sales tax reform was legislated. Since it was not removed at that time, it can be regarded as "permanent". Thus, the effective federal corporate tax rate is 28(1.03) = *28.84 percent.*

Investment Tax Credit: applies to mine plant and machinery, mill facility and infrastructure capital. The investment tax credit is deducted from the federal corporate income tax which would otherwise be payable to determine the net tax payable. The maximum deduction in any year is 75 percent of the federal corporate income tax otherwise payable. Excess credits may be carried back for three years and forward for ten years.

The rate of tax credit is 15 percent for applicable investment in the Atlantic Provinces and the Gaspé region of Québec.

Provincial and Territorial Corporate Income Tax

Ontario

From 1993, income for Ontario corporate income tax will be derived in exactly the same way as income for federal corporate income tax. The applicable tax rate is 14.5 percent.

Northwest Territories

Income for Northwest Territories corporate income tax is derived in exactly the same way as income for federal corporate income tax. The applicable tax rate is 10 percent.

Saskatchewan

Income for Saskatchewan corporate income tax is derived in exactly the same way as income for federal corporate income tax. The applicable tax rate is 15 percent.

Provincial and Territorial Mining Tax and Royalty

Ontario

Cash Flow Format:

Revenue
Less: Operating Cost

Net Income before Allowance
Less: Depreciation Allowance
Exploration Expenditures

Income for Processing Allowance
Less: Processing Allowance

Income for Ontario Mining Tax
Ontario Mining Tax

Depreciation Allowance: mine development capital costs at 100 percent per year; mine plant and equipment at 30 percent per year on a straight-line basis; mill, infrastructure and all other capital costs at 15 percent per year on a straight-line basis.

Processing Allowance: annual rate applied to the original cost of processing assets but not to be less than 15 percent nor more than 65 percent of income for processing allowance.

8% if ore concentrated
12% if ore smelted in Canada
16% if ore refined in Canada
20% if ore refined or fabricated in northern Ontario

Rate applies to all processing assets up to and including final stage.

The 12 percent rate applies to gold mill assets if the facility includes a smelter which produces doré or impure bullion.

Three-Year Tax-Exempt Period: a new mine is exempt from Ontario mining tax for a period of three years from the start of production. Discretionary deductions for exploration and development costs are not required to be deducted in determining the amount of exempt income. These deductions can be saved and used later after the expiry of the exempt period.

Ontario Mining Tax:

income for mining tax	marginal rate
up to $500,000	exempt
$500,000 and over	20%

Northwest Territories

Cash Flow Format:

Revenue
Less: Operating Cost

Net Income before Allowances
Less: Depreciation Allowance
Exploration Expenditures

Income for Processing Allowance
Less: Processing Allowance

Income for Northwest Territories Mining Tax
Northwest Territories Mining Tax

Depreciation Allowance: all capital costs except post-production mine development capital costs allowable at 15 percent per year on a straight-line basis; post-production mine development capital costs allowable at 100 percent.

Processing Allowance: 8 percent per year of the original cost of processing assets but not to be less than 15 percent nor more than 65 percent of the income for processing allowance.

Northwest Territories Mining Tax:

income for mining tax	marginal rate
up to $10,000	exempt
$10,000 - $1 million	3%
$1 million - $5 million	5%
$5 million - $10 million	6%
$10 million and over	+ 1% for each additional $5 million up to 12% maximum

Saskatchewan - Old Uranium Royalty

Basic Royalty: 3 percent of sales revenue.

- allowable deduction in computing "operating profit" for the graduated profit royalty.

Graduated Profit Royalty:

Operating Profit: Capital Investment Ratio	Incremental Royalty Rate on Operating Profit
less than 15%	0
15% - 25%	15%
25% - 45%	30%
greater than 45%	50%

e.g. if operating profit = $8,207,806
capital investment = $17,599,126

(8,207,806 / 17,599,126) (100) = 46.6%

.15 (17,599,126) = 2,639,869
.25 (17,599,126) = 4,399,781
.45 (17,599,126) = 7,919,607

therefore, royalty payable is calculated as follows:

.15 (4,399,781	- 2,639,869) =	263,987
+ .30 (7,919,607	- 4,399,781) =	1,055,947
+ .50 (8,207,806	- 7,919,607) =	144,100
		$1,464,034

Capital Investment:

- includes expenditures made each year on exploration, development, and construction in Saskatchewan for the purposes of finding and delineating a uranium deposit and building a uranium mine/mill complex;

- excludes "social infrastructure" and "working capital" expenditures;

- each year's expenditures are "grossed up" by multiplying them by an "interest rate factor" which is that year's average of the "prime rate" plus 10 percent of the prime rate. This interest rate factor is applied to the capital expenditure figure for any and all previous years. This procedure is repeated each year until the start of commercial production;

- at the start of commercial production, the "grossed up" capital investment figure becomes fixed. This "capital investment" becomes the denominator in the ratio used to determine the graduated profit royalty to be paid.

Operating Profit

Sales Revenue
Less: Production Costs
Administrative and Corporate Expense Allowance
Marketing Expense Allowance
Working Capital Allowance
Basic Royalty Payment
Capital Recovery Allowance

Operating Profit

- the "operating profit" figure, calculated each year from the start of commercial production, becomes the numerator in the ratio used to determine the graduated profit royalty to be paid.

Sales Revenue: gross annual income from the sale of U_3O_8 concentrate.

Production Costs: include operating costs, sustaining capital expenditures, other production phase capital expenditures, and a "social capital cost allowance".

The "social capital cost allowance" is 30 percent of social infrastructure capital expenditures per year on a declining-balance basis from the start of production.

Administrative and Corporate Expense Allowances: 5 percent of production costs.

Marketing Expense Allowance: 0.75 percent of sales revenue.

Working Capital Allowance: "interest rate factor" times 40 percent of production costs.

Basic Royalty Payment: 3 percent of sales revenue.

Capital Recovery Allowance:

- based on "capital investment" at the start of commercial production;
- this "capital investment" figure becomes the initial balance in the "capital recovery bank";
- the "capital recovery allowance" is drawn from this bank;
- the capital recovery allowance must be taken to the maximum extent possible each year, i.e. the "operating profit" figure has to go to zero if there is a sufficient balance in the capital recovery bank;
- the balance in the capital recovery bank at each year-end is then "grossed up" by the interest rate factor for that year.

Saskatchewan - New Uranium Royalty

Assessed in the same way as under the old uranium royalty regime (outlined above) except for the following changes.

Basic Royalty: 5 percent of sales revenue

- no longer qualifies as a deduction in computing "operating profit" for the graduated profit royalty;
- qualifies as a bottom-line credit against the "graduated profit royalty otherwise payable". This credit can be carried forward without restriction, and must be used to reduce to zero any graduated profit royalty otherwise payable in the year.

Graduated Profit Royalty Otherwise Payable:

Operating Profit per Kilogram U_3O_8 Sold	Incremental Royalty Rate on Operating Profit
less than $2	0
$2 - $20	15%
$20 - $50	34%
greater than $50	50%

- the operating profit brackets are indexed for inflation beginning in 1991.

Graduated Profit Royalty:

Graduated Profit Royalty Otherwise Payable
Less: Basic Royalty Payable
Basic Royalty Credit Carried Forward from Year X−1

If negative: Basic Royalty Credit to be Carried Forward to Year X+1
If positive: Graduated Profit Royalty Payable

Saskatchewan - Metallic Minerals Royalty

Cash Flow Format:

Revenue
Less: Operating Cost

Net Income before Allowances
Less: Depreciation Allowance
Exploration Expenditures

Income for Processing Allowance
Less: Processing Allowance

Income for Saskatchewan Mining Tax
Saskatchewan Mining Tax

Depreciation Allowance: mine development expenditures and mine plant and machinery capital costs allowable at 100 percent. Capital costs of processing, housing, and townsite facilities allowable at 30 percent per year on a declining-balance basis. For capital expenditures for road and power facilities, assume half is written off at 100 percent, and the other half at 30 percent per year declining balance. Assume 70 percent of infrastructure capital expenditures is deducted at 30 percent per year declining balance, and the remaining 30 percent of the infrastructure at 100 percent.

Processing Allowance: 8 percent per year of the original cost of processing assets but not to be less than 20 percent nor more than 65 percent of the income for processing allowance for copper-zinc deposits, and not to be less than 15 percent or more than 65 percent of income for other deposits.

Saskatchewan Mining Tax: 12.5 percent of income for Saskatchewan mining tax.

Appendix III

Australian Taxation Systems

Commonwealth Corporate Income Tax

Although there are a number of special features in the Australian tax system affecting the mining industry, in most respects the legislation applies in the same manner for all types of corporations.

The following taxation rules incorporate the changes contained in the government's May 1988 mini-budget and in its August 1989 budget announcement.

Cash Flow Format

Revenue
Less: State Royalty Payments
Operating Costs

Net Income Before Allowances
Less: Carried Loss (from year X−1)
Less New Deductions: Research and Development Expenditures
Exploration Expenditures
Capital Expenditures for Normal Depreciable Assets
Capital Expenditures for Special Mining Assets
Transportation and Port Facilities
Payments for Purchase of Mining Property

If negative: Carried Loss (for year X+1)
If positive: Income for Commonwealth Income Taxation
Commonwealth Income Taxation

Carried Loss

Revenue and deductions may be "pooled" within a mining company for Australian income tax purposes.

To the extent that net income is not available to absorb new deductions in any given year (and any carried loss from the previous year), the balance constitutes a "carried loss" which may be carried forward to the next year for deduction. Losses may be carried forward indefinitely. From 1984, companies are allowed to transfer losses between individual companies in their group where there is 100 percent common ownership.

New Deductions

The taxation system makes a distinction between capital expenditures for the following two types of assets.

1. Normal Depreciable Assets: hoists, mine plant and machinery, processing plant and machinery, power and water facilities.

2. Special Mining Assets: mine access and development; buildings, housing and townsite facilities which are on or adjacent to a mining property.

"New Deductions" are based on capital expenditures and are determined according to the following rules.

Research and Development Expenditures:

To provide a taxation incentive for research and development activities, qualifying expenditures can be deducted at the rate of 150 percent in the year incurred. Qualifying R&D projects must meet the following criteria:

- demonstrate the scientific method applied in a systematic progression of work from hypothesis to experiment, observation and evaluation, followed by logical conclusions;

- involve innovation or technical risk;

- be carried on for the purpose of acquiring new knowledge or creating new or improved materials, products, devices, processes or services.

A range of opportunities exist in the mining sector for using the R&D incentive to reduce the after-tax cost of the activities, including pilot plant design and test work related to the development of mines and mineral

processing plants based on mineralization of a unique or unusual character. Also, the following types of exploration activity qualify:

- new exploration strategies or techniques aimed at developing better conceptual generic or mineralization models or devices;
- R&D leading to predictive guidelines for exploration, such as ore vector research;
- R&D leading to new geophysical, geochemical, geological, and remote sensing techniques.

R&D expenditures incurred by a holding or associated company on behalf of a gold mining company can still be claimed as an allowable deduction if the holding (or associated) company acts in the capacity of a contractor to the gold mining company, and if the expenditures incurred by the contract company are not on-charged to the gold mining company.

Exploration Expenditures:

Includes mapping, geological, geophysical and geochemical work, drilling, exploration shafts and development, prior to making a decision to commence mining other than those expenditures which qualify for the R&D deduction as outlined above. Feasibility studies, metallurgical testing and similar pre-development work are usually allowable. Exploration expenditures are deductible in the year incurred, the deduction being limited to the amount of income available from any source after all other deductions have been taken.

Undeducted expenditures may be accumulated and deducted against any subsequent mining income.

Capital Expenditures for Normal Depreciable Assets:

The write-off of normal depreciable assets for tax purposes is based on the straight-line ("prime cost") method. The applicable rate, comprising a basic rate and a "loading" which is currently 20 percent, is published by the Commissioner of Taxation.[22] For example, the applicable rate for mining and mineral processing plant and machinery is generally 9 percent (the basic

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[22] The published straight-line rate is, theoretically, (1.0/useful life of asset) x 100 percent. The "loading" represents a provision for accelerated depreciation.

rate of 7.5 percent plus the 20 percent loading). However, straight-line depreciation rates are higher for some types of capital expenditures – 24 percent for heavy-duty trucks, 12 percent for mine cars, and 18 percent for conveyor belts, for example.

Alternatively, a company can opt for declining-balance ("diminishing value") depreciation at 1.5 times the applicable straight-line rate. For example, the declining-balance rate for most types of mining and mineral processing plant and machinery is 1.5(9.0) = 13.5 percent.

Normal depreciable assets are deductible from the time the assets are put into use or installed ready for use and held in reserve. For preproduction capital expenditures, this *time* can be assumed to correspond to the start of mine production.

Capital Expenditures for Special Mining Assets:

These capital expenditures are deductible at 10 percent per year on a straight-line basis when the remaining mine life is ten years or more, or by equal annual amounts where the remaining mine life is less than ten years.

Buildings which are not specifically situated on or adjacent to the mining property or at the treatment site are eligible to be written off over 40 years (i.e. 2.5 percent straight-line) if the buildings are used in the income-producing activities of the business. This special deduction does not apply to buildings which are primarily used for residential purposes.

Special mining assets are deductible starting in the year in which the expenditure is incurred.

Transportation Facilities:

Includes capital expenditure for roads, railways and pipelines for use in transporting products from the mine site. Port development costs for dredging, breakwaters, navigational aids and surveys are also included. Road vehicles, railway rolling stock, ships, etc.; are not covered by this provision but are eligible for depreciation and investment allowance as "normal depreciable assets".

These capital expenditures are deducted at 10 percent straight-line depreciation.

Port Facilities:

Jetties and any plant and machinery, such as cranes, conveyors and ship-loaders, are eligible for depreciation and investment allowance as "normal depreciable assets" as outlined above. The provision of housing and townsite facilities at port sites is not deductible.

Payments for Purchase of Mining Property:

The value of plant and equipment specified in the purchase agreement for a mining property is allowable as "new deductions". In order that a purchaser may receive any other deductions with respect to acquisition costs, the vendor is required to give notice to the purchaser detailing the amount of the deductions transferred. The amount cannot exceed the vendor's actual expenditure on the property but it may exceed the actual expenditure less deductions already claimed if the vendor suffers a recapture with respect to the excess. The purpose of this limitation is to place the purchaser in the same position with respect to the deductions as the vendor was immediately prior to the sale.

Commonwealth Income Tax

From July 1988, Australian income tax is imposed at the normal corporate rate of 39 percent of the income.

From 1990, 85 percent of corporate income tax will be due and payable four weeks after the end of the financial year in which the income is earned. This means that the former one-year time lag in tax payments will no longer apply.

Gold mining income was completely exempt from Australian income tax until December 1990 provided:

- more than 50 percent of the mine's income was from gold, or
- more than 40 percent of the income of a gold-copper mine was from gold.

The thresholds of 50 percent and 40 percent were applied with respect to income from the date mining commenced on a property until the end of the taxation year. In other words, these tests were not applied to income in any single year, but on an accumulated basis.

As the gold mining income was exempt, the expenditure incurred was not an allowable deduction.

In May 1988, the Australian government announced its intention to remove the tax exemption on gold mining income from January 1991. Gold exploration expenditures incurred from May 1988 can be accumulated and carried forward for write-off against gold mining income from January 1991. Capital expenditures for gold mining must be depreciated on a straight-line basis over mine life from the date the costs are incurred until January 1991.[23] The unwritten-off balances are then available to be depreciated for tax purposes at the same rates which apply in determining taxable income for other mining activities. Thus, during the period May 1988 to December 1990, gold mining companies had an incentive to classify as much as possible of their expenditures as capital rather than operating costs.

For joint ventures, the costs and products are shared among the partners as specified in the agreement. Each partner is individually taxed according to the rules outlined above. This in effect allows for taxation of each partner on an integrated company basis, where otherwise, an individual project basis of taxation would apply.

Australian taxation of mining income is in no small part influenced by the substantial foreign ownership in the Australian mining industry and government policies directed towards its control. In this regard, special policy guidelines apply for the development of major mining projects. Briefly stated, the Australian government generally requires a minimum of 50 percent Australian equity (75 percent in the case of uranium) for new mining developments. However, if there are difficulties in securing local Australian equity, the government may allow a project to proceed with a lower level of domestic equity. The minimum Australian equity requirement applies only if investment in a mining project exceeds $10 million.

Withholding taxes on remittance to overseas residents are at the standard rates of 10 percent on interest and 30 percent (or 15 percent in the case of Canada and other countries where a tax treaty applies) on dividends. However, profits of an Australian branch of a non-resident company can be remitted to the foreign head office free of withholding tax. However, a branch profit tax of 5 percent must be paid, as mentioned above with respect to nonresidents.

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[23] Since 1984, the statutory maximum mine life for tax purposes has been 10 years.

State Royalty Payments

Format

Metal Revenue (cif market)
Less: Smelter Payments and Transportation Costs

Concentrate Revenue (fob mine)
Less: Operating Cost
Depreciation Allowance (assume straight line over mine life)

Net Income

Northern Territory

18 percent of net income. Depreciation is calculated on a straight-line basis over the shorter of economic asset life or 15 years. Accumulated losses from previous years can be carried forward indefinitely.

This system will eventually apply to all mines in the Territory. For uranium mines and mines operating or under construction before July 1, 1982, application of the new system is deferred. In the cases of gold and washed bauxite, the applicable rates are:

- 1.25 percent of concentrate revenue;
- 2.5 percent of concentrate revenue if project is located in an aboriginal reserve.

For uranium mines in the Northern Territory, the determination of government imposts is complex, variable, and uncertain. Legally, the Commonwealth (i.e. the federal government) levies royalties on uranium mining which it pays to the "two legislated tax-imposing authorities" of the Northern Territory, namely the Northern Territory government and the Aboriginal movement. The royalties, expressed as a percentage of gross revenue at the point of sale to the consumer, are negotiated for individual mining leases.

Northern Territory Royalty

- 1.25 percent of revenue for the Nabarlek and Ranger leases.

Aboriginal Royalty

- payments are made into the Aboriginals Benefits Trust Account (ABTA). The royalty is 2.50 percent of revenue in the case of Nabarlek and 4.25 percent of revenue for the Ranger mine. Further payments also are required under the terms of the lease agreements. Nabarlek, for example, was required to refund 2.00 percent of revenue plus initial and annual lease payments to the Northern Land Council (NLC) for the local aboriginal traditional landowners. The Ranger mine also made an initial lease payment and pays an additional $200,000 per year (indexed from 1980) to the NLC. The NLC has a court action against the federal government and the Ranger mine claiming a further $200 million in payments since 1980.

Environment Duty

- in addition to the above royalties, a duty of $1.30 per kilogram of uranium concentrate exported from the Northern Territory is applied to fund environmental monitoring of the Alligator Rivers region.

Admittedly, it is difficult to generalize from and simplify the actual uranium mining lease agreements in the Northern Territory. Nevertheless, for study purposes, we suppose that total royalties equivalent to 6.25 percent of revenue plus the export duty of $1.30 per kilogram of concentrate would not overstate the imposts which currently would be levied on a uranium mining project in this jurisdiction.

Queensland

The existing Queensland royalty system came into effect in 1974. The "percentage of value" or *ad valorem* method was adopted as the preferred approach where practicable. A broad policy of assessing royalties at 10 percent of the value of the mineral loaded ready for shipment from the field is adopted, with allowances being made for minerals mined in differing circumstances. As a result, different rates apply for different broad categories of minerals and very few minerals are currently assessed at the full 10 percent. In some cases, the percentage of value method is considered unsuitable and other types of royalty are applied.

The basic rate of 10 percent applies to oil, gas, exported bauxite, and some other minerals. The rate is reduced to 5 percent if "adequate" rail freight profits are deemed to be derived. The 5-percent rate is levied on exported

open cut coal, base metal and tin concentrate revenue, and mineral sands. A variety of other rates also apply, including

- 4 percent for underground coal;
- the greater of 2 percent of revenue or 5 percent of net income for gold and uranium.

For low-unit-value mineral commodities, tonnage royalties are applied, especially where there is no arm's-length sale. For example, the royalty on limestone production is $0.30 per tonne.

Where there is considerable downstream processing, the percentage of revenue approach is modified if there is no arm's-length sale of the basic ores. In the case of Mount Isa, the following royalty scheme applies:

- copper ore and lead/zinc/silver ore are separately assessed;
- $2.00 per tonne varying with the ratio of the current realizable value of the contained metals per tonne of ore to the average realizable value in 1973-74.

Also, government freight rates in Queensland are believed to include a royalty component.

A major review of the royalty system was carried out in 1987. No action has been taken on the recommendations made in this review.

South Australia - General Royalty

2.5 percent of concentrate revenue

South Australia - Olympic Dam Royalty

Two state royalty components:

- *ad valorem* royalty;
- surplus-related royalty.

These components are determined as follows.

1. Minesite Revenue
2. *Ad Valorem Royalty*

3. Operating Costs
4. Capital Expenditures (excluding working capital)
5. Working Capital
6. Interest Payments (not used below)

7. Commonwealth Income Tax Allowance
8. Depreciation Allowance for Surplus-Related Royalty
9. Funds Employed
10. Project Surplus
11. Project Return
12. Surplus-Related Royalty Rate (C)

13. Post-Threshold Project Surplus
14. *Surplus-Related Royalty*

2. *Ad Valorem Royalty*

- 2.5 percent of minesite revenue for the first five years of mine production;

- 3.5 percent of minesite revenue from the sixth year of mine production.

7. Commonwealth Income Tax Allowance

- determined as follows

1. Minesite Revenue
Less: 3. Operating Costs
2. *Ad Valorem* Royalty

Project Cash Surplus
Less: 8. Depreciation Allowance for Surplus-Related Royalty

Income for Commonwealth Income Tax Allowance

Commonwealth Income Tax Allowance =
(Income for Commonwealth Income Tax Allowance)
x (Commonwealth Income Tax Rate)

= (items 1 - 3 - 2 - 8) (0.39)

8. Depreciation Allowance for Surplus-Related Royalty

- individual project basis; depreciation allowance cannot be used to create a carried loss;
- 20 percent declining-balance depreciation per year on all capital expenditures except working capital (item 4) up to the limit of project income (item 1 - item 3);
- unwritten-off depreciation balance carried forward to the next year is indexed for inflation (using the consumer price index).

9. Funds Employed

Project Funds Employed = Unwritten-off Balance at Year End after Deducting Depreciation Allowance.

Total Funds Employed = Project Funds Employed + Working Capital.

Mid-Year Funds Employed = Total Funds Employed (Year X-1 + Year X)/2

5-Year Moving Average "Funds Employed" (item 9) = Mid-Year Funds Employed

- averaged from the start of production up to and including year X until the fifth production year, and then five-year moving average.

10. Project Surplus

1. Minesite Revenue
Less: 3. Operating Costs
2. *Ad Valorem* Royalty
7. Commonwealth Income Tax Allowance
8. Depreciation Allowance for Surplus-Related Royalty

Annual Project Surplus

5-Year Moving Average "Project Surplus" (item 10) = Annual Project Surplus

- averaged from the start of production up to and including year X until the fifth production year, and then five-year moving average.

11. Project Return = (item 10 / item 9) 100

e.g. if • 5-year moving average funds employed = $466.3 million;
• 5-year moving average project surplus = $83.2 million;

• project return = (83.2 / 466.3) 100 = *17.8 percent.*

12. Surplus-Related Royalty Rate (*C*)

- *C* is a function of *Q*

$$\text{where } Q = \frac{\text{Project Return (item 11)}}{\text{10-Year Bond Rate}}$$

- assume 10-Year Bond Rate = annual rate of inflation + 5%

e.g. if inflation rate = 5%
10-Year Bond Rate = 10%

- when *Q* is less than 1.2; *C* = 0;
- when *Q* is greater than 1.2 and less than 1.8;

$$C = \frac{10\,(Q - 1.2)}{0.6}\ \% \ ; \ Cmax = 10\%$$

- when *Q* is greater than 1.8 and less than 2.4;

$$C = \frac{10\,(Q - 1.2)}{0.6} - \frac{5\,(Q - 1.8)}{0.6} = \frac{5\,(Q - 0.6)}{0.6}\ \% \ ;$$

$Cmax = 15\%$

- when *Q* is greater than 2.4 ; *C* = 15%.

- e.g. if project return = 17.8% and 10-year bond rate = 10%

  $Q = 17.8/10 = 1.78$

$$C = \frac{10\ (1.78 - 1.2)}{0.6} = 9.67\%$$

13. Post-Threshold Project Surplus

Annual Project Surplus
Less: 1.2 (10-Year Bond Rate)(Mid-Year Funds Employed)/100

Annual Post-Threshold Project Surplus

e.g. if • annual project surplus = $107.9 million;
- 10-year bond rate = 10%;
- mid-year funds employed = $353.0 million.

- annual post-threshold project surplus
  = 107.9 - 1.2(10)(353.0)/100 = $65.54 million.

5-Year Moving Average "Post-Threshold Project Surplus"
(item 13) = Annual Post-Threshold Project Surplus

- averaged from the start of production in the same way as items 9 and 10.

14. *Surplus-Related Royalty*

$$= \frac{C\ (item\ 13)}{100} - 0.01\ (\ T\ ),$$

where T = zero for the first five years of mine production; minesite revenue from the sixth year

e.g. if • C = 9.67%
- 5-year moving average post-threshold surplus = $47.6 million;
- T = $218.5 million

- surplus-related royalty payment

$$= \frac{9.67\ (47.6)}{100} - .01\ (218.5) = \$2.418\ \textit{million}$$

Western Australia

Gold: nil

Nickel, Tin:
2.5 percent of metal revenue

Cobalt, Silver, Platinoids, Mineral Sands:
2.5 percent of concentrate revenue

Copper, Lead, Zinc, Tungsten, Tantalum, Uranium:
5 percent of concentrate revenue

Iron Ore:
7.5 percent of fob mine revenue for lump ore,
3.75 percent for fine ore.
Special agreements apply to individual producers.

Diamonds:
The lower of 7.5 percent of fob mine revenue and 22.5 percent of net income.

A major review of the royalty system was carried out by Paul Bradley in 1986-87. No action has been taken on the recommendations made in his report.

Appendix IV

Before-Tax Project Evaluation Results

Table 12. Before-tax cash flow characteristics and economic indicators under base case conditions

Characteristic	Uranium Project			
	High-Grade Unconformity	Quartz-Pebble Conglomerate	Conventional-Grade Unconformity	Uranium-Polymetallic
Time periods (years)				
Development	3	4	3	4
Production	14	27	10	30
Undiscounted values ($ million)				
Revenue	6,947	4,352	1,984	12,763
Preproduction capital cost	619	513	340	872
Production costs	1,067	2,000	510	5,250
Return of working capital	20	17	15	41
Cash flow	5,281	1,856	1,149	6,682
Economic indicators				
Net present value at 10% ($ million)	1,817	151	404	928
Rate of return (percent)	45	14	31	21

Table 13. Before-tax cash flow characteristics and economic indicators as a function of market price

Characteristic	Uranium Project			
	High-Grade Unconformity	Quartz-Pebble Conglomerate	Conventional-Grade Unconformity	Uranium-Polymetallic
Revenue ($ million)				
Lower-limit prices	4,117	2,579	1,176	7,405
Expected prices	6,947	4,352	1,984	12,763
Upper-limit prices	10,587	6,632	3,023	19,780
Cash flow ($ million)				
Lower-limit prices	2,451	83	341	1,324
Expected prices	5,281	1,856	1,149	6,682
Upper-limit prices	8,921	4,136	2,188	13,699
Net present value at 10% ($ million)				
Lower-limit prices	698	-267	31	-222
Expected prices	1,817	151	404	928
Upper-limit prices	3,256	689	884	2,434
Rate of return (percent)				
Lower-limit prices	27	1	12	6
Expected prices	45	14	31	21
Upper-limit prices	63	24	47	34

Table 14. Before-tax net present value as a function of the cost of capital

Net present value ($ million)	Uranium Project			
	High-Grade Unconformity	Quartz-Pebble Conglomerate	Conventional-Grade Unconformity	Uranium-Polymetallic
at 5 percent	3,039	606	683	2,405
at 10 percent	1,817	151	404	928
at 15 percent	1,114	-35	232	324

Appendix V

After-Tax Project Evaluation Results

Table 15. Effect of taxation on economic indicators under base case conditions

Tax Jurisdiction	Net Present Value at 10% ($ million)				Rate of Return (percent)			
	High-Grade Unconformity Project	Quartz-Pebble Conglomerate Project	Conventional-Grade Unconformity Project	Uranium-Polymetallic Project	High-Grade Unconformity Project	Quartz-Pebble Conglomerate Project	Conventional-Grade Unconformity Project	Uranium-Polymetallic Project
Canada								
Ontario	951	1	190	379	35	10	22	16
Northwest Territories	1,040	27	208	454	35	11	23	17
Saskatchewan								
New uranium royalty	589	-21	116	285	28	9	18	15
Old uranium royalty	536	-2	130	290	27	10	19	15
Metallic minerals royalty	926	-14	168	366	32	10	21	15
Australia								
Northern Territory	865	-52	139	277	30	8	19	14
Queensland	931	-17	165	366	32	10	20	15
South Australia								
General royalty	954	-19	169	366	32	9	20	15
Olympic Dam royalty	875	-28	155	333	31	9	20	15
Western Australia	912	-34	155	337	31	9	19	15

Table 16. Effect of taxation on economic indicators for lower-limit prices

Tax Jurisdiction	Net Present Value at 10% ($ million)				Rate of Return (percent)			
	High-Grade Unconformity Project	Quartz-Pebble Conglomerate Project	Conventional-Grade Unconformity Project	Uranium-Polymetallic Project	High-Grade Unconformity Project	Quartz-Pebble Conglomerate Project	Conventional-Grade Unconformity Project	Uranium-Polymetallic Project
Canada								
Ontario	319	-276	-28	-303	20	-1	8	4
Northwest Territories	358	-274	-21	-289	20	0	8	5
Saskatchewan								
New uranium royalty	248	-304	-43	-357	18	-2	7	3
Old uranium royalty	246	-292	-34	-326	18	-1	7	4
Metallic minerals royalty	289	-281	-48	-323	19	0	6	4
Australia								
Northern Territory	225	-324	-75	-404	16	-3	4	2
Queensland	282	-288	-52	-326	18	-1	6	4
South Australia								
General royalty	288	-290	-53	-331	18	-1	6	4
Olympic Dam royalty	266	-293	-55	-338	18	-1	6	3
Western Australia	263	-303	-62	-350	17	-2	5	3

Table 17. Effect of taxation on economic indicators for upper-limit prices

Tax Jurisdiction	Net Present Value at 10% ($ million)				Rate of Return (percent)			
	High-Grade Unconformity Project	Quartz-Pebble Conglomerate Project	Conventional-Grade Unconformity Project	Uranium-Polymetallic Project	High-Grade Unconformity Project	Quartz-Pebble Conglomerate Project	Conventional-Grade Unconformity Project	Uranium-Polymetallic Project
Canada								
Ontario	1,760	307	467	1,214	49	18	36	27
Northwest Territories	1,913	359	501	1,375	48	19	36	27
Saskatchewan								
New uranium royalty	869	160	227	674	35	15	26	21
Old uranium royalty	792	235	248	690	34	17	27	22
Metallic minerals royalty	1,739	299	440	1,225	46	18	33	25
Australia								
Northern Territory	1,688	256	413	1,139	44	16	31	24
Queensland	1,765	296	443	1,239	45	17	33	25
South Australia								
General royalty	1,809	301	454	1,262	46	17	33	25
Olympic Dam royalty	1,657	276	415	1,157	44	17	32	24
Western Australia	1,745	277	433	1,219	45	17	32	25

Table 18. Effect of taxation on net present value as a function of the cost of capital ($ million)

Tax Jurisdiction	5-percent Cost of Capital				15-percent Cost of Capital			
	High-Grade Unconformity Project	Quartz-Pebble Conglomerate Project	Conventional-Grade Unconformity Project	Uranium-Polymetallic Project	High-Grade Unconformity Project	Quartz-Pebble Conglomerate Project	Conventional-Grade Unconformity Project	Uranium-Polymetallic Project
Canada								
Ontario	1,627	260	356	1,178	557	-107	88	44
Northwest Territories	1,803	324	390	1,379	601	-96	97	76
Saskatchewan								
New uranium royalty	1,063	224	244	994	314	-123	36	-11
Old uranium royalty	963	260	264	955	285	-111	47	1
Metallic minerals royalty	1,428	253	332	1,214	523	-122	68	20
Australia								
Northern Territory	1,552	191	295	1,071	473	-147	44	-40
Queensland	1,653	256	333	1,239	518	-126	63	13
South Australia								
General royalty	1,689	254	338	1,243	533	-127	66	12
Olympic Dam royalty	1,563	231	317	1,159	482	-131	57	-3
Western Australia	1,625	226	318	1,188	505	-137	56	-5

Appendix VI

Government Tax Revenues

Table 19. Total tax payments under base case conditions ($ million)

Tax Jurisdiction	Undiscounted Tax Payments				Tax Payments Discounted at 10 percent			
	High-Grade Unconformity Project	Quartz-Pebble Conglomerate Project	Conventional-Grade Unconformity Project	Uranium-Polymetallic Project	High-Grade Unconformity Project	Quartz-Pebble Conglomerate Project	Conventional-Grade Unconformity Project	Uranium-Polymetallic Project
Canada								
Ontario	2,431	907	518	3,237	866	150	214	549
Northwest Territories	2,080	729	457	2,644	777	124	196	474
Saskatchewan								
New uranium royalty	3,358	978	691	3,681	1,228	172	289	643
Old uranium royalty	3,552	899	662	3,935	1,281	153	274	638
Metallic minerals royalty	2,364	872	543	3,012	891	165	236	562
Australia								
Northern Territory	2,460	989	588	3,305	952	203	265	651
Queensland	2,297	846	532	2,910	886	168	239	562
South Australia								
General royalty	2,236	848	524	2,892	863	170	235	562
Olympic Dam royalty	2,451	914	557	3,141	942	179	249	595
Western Australia	2,342	914	554	3,024	905	185	249	591

Table 20. Total tax payments for lower-limit prices ($ million)

Tax Jurisdiction	Undiscounted Tax Payments				Tax Payments Discounted at 10 percent			
	High-Grade Unconformity Project	Quartz-Pebble Conglomerate Project	Conventional-Grade Unconformity Project	Uranium-Polymetallic Project	High-Grade Unconformity Project	Quartz-Pebble Conglomerate Project	Conventional-Grade Unconformity Project	Uranium-Polymetallic Project
Canada								
Ontario	1,133	103	160	711	379	9	59	80
Northwest Territories	969	81	139	572	340	7	52	67
Saskatchewan								
New uranium royalty	1,307	202	182	853	450	37	74	135
Old uranium royalty	1,338	168	166	704	452	25	65	104
Metallic minerals royalty	1,135	112	194	702	409	14	79	101
Australia								
Northern Territory	1,249	264	242	1,028	473	57	106	182
Queensland	1,106	142	193	707	416	21	83	104
South Australia								
General royalty	1,089	150	196	730	410	23	84	109
Olympic Dam royalty	1,161	164	201	779	432	26	86	116
Western Australia	1,151	194	214	819	435	36	93	128

Table 21. Total tax payments for upper-limit prices ($ million)

Tax Jurisdiction	Undiscounted Tax Payments				Tax Payments Discounted at 10 percent			
	High-Grade Unconformity Project	Quartz-Pebble Conglomerate Project	Conventional-Grade Unconformity Project	Uranium-Polymetallic Project	High-Grade Unconformity Project	Quartz-Pebble Conglomerate Project	Conventional-Grade Unconformity Project	Uranium-Polymetallic Project
Canada								
Ontario	4,100	1,989	979	6,588	1,495	382	417	1,220
Northwest Territories	3,511	1,627	865	5,399	1,343	330	383	1,059
Saskatchewan								
New uranium royalty	6,329	2,707	1,516	9,195	2,387	529	657	1,760
Old uranium royalty	6,580	2,442	1,477	9,551	2,464	454	636	1,744
Metallic minerals royalty	3,948	1,859	995	6,059	1,517	390	444	1,209
Australia								
Northern Territory	4,017	1,964	1,032	6,309	1,568	433	471	1,295
Queensland	3,827	1,801	969	5,860	1,491	393	441	1,195
South Australia								
General royalty	3,710	1,772	945	5,736	1,447	388	430	1,172
Olympic Dam royalty	4,108	1,930	1,032	6,325	1,599	413	469	1,277
Western Australia	3,872	1,873	991	5,935	1,511	412	451	1,215

Table 22. Total discounted tax payments as a function of the cost of capital ($ million)

Tax Jurisdiction	5-percent Cost of Capital				15-percent Cost of Capital			
	High-Grade Unconformity Project	Quartz-Pebble Conglomerate Project	Conventional-Grade Unconformity Project	Uranium-Polymetallic Project	High-Grade Unconformity Project	Quartz-Pebble Conglomerate Project	Conventional-Grade Unconformity Project	Uranium-Polymetallic Project
Canada								
Ontario	1,412	346	327	1,226	557	72	144	280
Northwest Territories	1,236	282	294	1,026	513	60	135	250
Saskatchewan								
New uranium royalty	1,976	382	439	1,411	800	88	196	335
Old uranium royalty	2,076	346	419	1,450	829	76	185	323
Metallic minerals royalty	1,411	353	352	1,191	591	86	163	304
Australia								
Northern Territory	1,487	415	388	1,334	641	112	188	364
Queensland	1,386	350	350	1,166	596	91	169	311
South Australia								
General royalty	1,350	352	345	1,162	581	92	166	312
Olympic Dam royalty	1,476	375	366	1,246	632	96	175	327
Western Australia	1,414	382	365	1,217	609	102	176	329

Table 23. Tax payments by component for high-grade unconformity project under base case conditions ($ million)

Tax Jurisdiction	Undiscounted Tax Payments				Tax Payments Discounted at 10 percent			
	Federal Income Tax	Provincial Income Tax	Provincial/State Mining Tax and Royalty	Total Payments	Federal Income Tax	Provincial Income Tax	Provincial/State Mining Tax and Royalty	Total Payments
Canada								
Ontario	1,144	575	712	2,431	424	213	229	866
Northwest Territories	1,144	397	539	2,080	424	147	206	777
Saskatchewan								
New uranium royalty	1,144	595	1,619	3,358	424	220	584	1,228
Old uranium royalty	1,144	595	1,813	3,552	424	220	637	1,281
Metallic minerals royalty	1,144	595	625	2,364	424	220	247	891
Australia								
Northern Territory	1,918	-	542	2,460	738	-	214	952
Queensland	2,023	-	274	2,297	780	-	106	886
South Australia								
General royalty	2,062	-	174	2,236	794	-	69	863
Olympic Dam royalty	1,924	-	527	2,451	744	-	198	942
Western Australia	1,995	-	347	2,342	768	-	137	905

- not applicable

Table 24. Tax payments by component for quartz-pebble conglomerate project under base case conditions ($ million)

Tax Jurisdiction	Undiscounted Tax Payments				Tax Payments Discounted at 10 percent			
	Federal Income Tax	Provincial Income Tax	Provincial/State Mining Tax and Royalty	Total Payments	Federal Income Tax	Provincial Income Tax	Provincial/State Mining Tax and Royalty	Total Payments
Canada								
Ontario	410	206	291	907	70	35	45	150
Northwest Territories	410	142	177	729	70	25	29	124
Saskatchewan								
New uranium royalty	410	213	355	978	70	37	65	172
Old uranium royalty	410	213	276	899	70	37	47	153
Metallic minerals royalty	410	213	248	872	70	37	58	165
Australia								
Northern Territory	650	-	339	989	123	-	80	203
Queensland	740	-	106	846	145	-	23	168
South Australia								
General royalty	739	-	109	848	144	-	26	170
Olympic Dam royalty	696	-	218	914	139	-	40	179
Western Australia	697	-	217	914	134	-	51	185

- not applicable

Table 25. Tax payments by component for conventional-grade unconformity project under base case conditions ($ million)

Tax Jurisdiction	Undiscounted Tax Payments				Tax Payments Discounted at 10 percent			
	Federal Income Tax	Provincial Income Tax	Provincial/State Mining Tax and Royalty	Total Payments	Federal Income Tax	Provincial Income Tax	Provincial/State Mining Tax and Royalty	Total Payments
Canada								
Ontario	254	128	136	518	108	54	52	214
Northwest Territories	254	88	115	457	108	37	51	196
Saskatchewan								
New uranium royalty	254	132	304	690	108	56	125	289
Old uranium royalty	254	132	276	662	108	56	110	274
Metallic minerals royalty	254	132	157	543	108	56	72	236
Australia								
Northern Territory	433	-	155	588	194	-	71	265
Queensland	469	-	63	532	210	-	29	239
South Australia								
General royalty	474	-	50	524	212	-	23	235
Olympic Dam royalty	452	-	105	557	204	-	45	249
Western Australia	455	-	99	554	203	-	46	249

- not applicable

Table 26. Tax payments by component for uranium-polymetallic project under base case conditions ($ million)

Tax Jurisdiction	Undiscounted Tax Payments				Tax Payments Discounted at 10 percent			
	Federal Income Tax	Provincial Income Tax	Provincial/State Mining Tax and Royalty	Total Payments	Federal Income Tax	Provincial Income Tax	Provincial/State Mining Tax and Royalty	Total Payments
Canada								
Ontario	1,456	732	1,049	3,237	257	129	163	549
Northwest Territories	1,456	505	683	2,644	257	90	127	474
Saskatchewan								
New uranium royalty	1,456	757	1,467	3,680	257	134	252	643
Old uranium royalty	1,456	757	1,722	3,935	257	134	247	638
Metallic minerals royalty	1,456	757	799	3,012	257	134	171	562
Australia								
Northern Territory	2,309	-	996	3,305	437	-	214	651
Queensland	2,563	-	347	2,910	494	-	68	562
South Australia								
General royalty	2,573	-	319	2,892	494	-	68	562
Olympic Dam royalty	2,415	-	726	3,141	472	-	123	595
Western Australia	2,489	-	535	3,024	476	-	115	591

- not applicable

Table 27. Discounted tax payments by component for high-grade unconformity project as a function of market price ($ million)

Tax Jurisdiction	Lower-Limit Prices				Upper-Limit Prices			
	Federal Income Tax	Provincial Income Tax	Provincial/State Mining Tax and Royalty	Total Payments	Federal Income Tax	Provincial Income Tax	Provincial/State Mining Tax and Royalty	Total Payments
Canada								
Ontario	185	93	101	379	735	370	391	1,496
Northwest Territories	185	64	91	340	735	255	353	1,343
Saskatchewan								
New uranium royalty	185	96	169	450	735	382	1,270	2,387
Old uranium royalty	185	96	171	452	735	382	1,347	2,464
Metallic minerals royalty	185	96	128	409	735	382	400	1,517
Australia								
Northern Territory	328	-	145	473	1,265	-	303	1,568
Queensland	366	-	50	416	1,313	-	178	1,491
South Australia								
General royalty	369	-	41	410	1,342	-	105	1,447
Olympic Dam royalty	356	-	76	432	1,246	-	353	1,599
Western Australia	354	-	81	435	1,302	-	209	1,511

- not applicable

Table 28. Discounted tax payments by component for quartz-pebble conglomerate project as a function of market price ($ million)

Tax Jurisdiction	Lower-Limit Prices				Upper-Limit Prices			
	Federal Income Tax	Provincial Income Tax	Provincial/State Mining Tax and Royalty	Total Payments	Federal Income Tax	Provincial Income Tax	Provincial/State Mining Tax and Royalty	Total Payments
Canada								
Ontario	4	2	3	9	180	91	111	382
Northwest Territories	4	1	2	7	180	63	87	330
Saskatchewan								
New uranium royalty	4	2	31	37	180	94	255	529
Old uranium royalty	4	2	19	25	180	94	180	454
Metallic minerals royalty	4	2	8	14	180	94	116	390
Australia								
Northern Territory	3	-	54	57	320	-	113	433
Queensland	9	-	12	21	346	-	47	393
South Australia								
General royalty	8	-	15	23	349	-	39	388
Olympic Dam royalty	7	-	19	26	333	-	80	413
Western Australia	6	-	30	36	334	-	78	412

- not applicable

Table 29. Discounted tax payments by component for conventional-grade unconformity project as a function of market price ($ million)

Tax Jurisdiction	Lower-Limit Prices				Upper-Limit Prices			
	Federal Income Tax	Provincial Income Tax	Provincial/State Mining Tax and Royalty	Total Payments	Federal Income Tax	Provincial Income Tax	Provincial/State Mining Tax and Royalty	Total Payments
Canada								
Ontario	31	15	13	59	211	106	100	417
Northwest Territories	31	10	11	52	211	73	99	383
Saskatchewan								
New uranium royalty	31	16	27	74	211	110	336	657
Old uranium royalty	31	16	18	65	211	110	315	636
Metallic minerals royalty	31	16	32	79	211	110	123	444
Australia								
Northern Territory	58	-	48	106	370	-	101	471
Queensland	72	-	11	83	388	-	53	441
South Australia								
General royalty	70	-	14	84	395	-	35	430
Olympic Dam royalty	69	-	17	86	371	-	98	469
Western Australia	66	-	27	93	381	-	70	451

- not applicable

Table 30. Discounted tax payments by component for uranium-polymetallic project as a function of market price ($ million)

Tax Jurisdiction	Lower-Limit Prices				Upper-Limit Prices			
	Federal Income Tax	Provincial Income Tax	Provincial/State Mining Tax and Royalty	Total Payments	Federal Income Tax	Provincial Income Tax	Provincial/State Mining Tax and Royalty	Total Payments
Canada								
Ontario	37	18	25	80	578	290	352	1,220
Northwest Territories	37	13	17	67	578	200	281	1,059
Saskatchewan								
New uranium royalty	37	19	79	135	578	300	882	1,760
Old uranium royalty	37	19	48	104	578	300	866	1,744
Metallic minerals royalty	37	19	45	101	578	300	331	1,209
Australia								
Northern Territory	40	-	142	182	987	-	308	1,295
Queensland	72	-	32	104	1,052	-	143	1,195
South Australia								
General royalty	69	-	40	109	1,066	-	106	1,172
Olympic Dam royalty	66	-	50	116	999	-	278	1,277
Western Australia	61	-	67	128	1,039	-	176	1,215

- not applicable

Appendix VII

Effective Tax Rates

Table 31. Effect tax rates under base case conditions (percent)

Tax Jurisdiction	Uranium Project			
	High-Grade Unconformity	Quartz-Pebble Conglomerate	Conventional-Grade Unconformity	Uranium-Polymetallic
Canada				
Ontario	48	99	53	59
Northwest Territories	43	82	49	51
Saskatchewan				
New uranium royalty	68	..	71	69
Old uranium royalty	70	..	68	69
Metallic minerals royal	49	..	58	61
Australia				
Northern Territory	52	..	66	70
Queensland	49	..	59	61
South Australia				
General royalty	48	..	58	61
Olympic Dam royalty	52	..	62	64
Western Australia	50	..	62	64

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Table 32. Effect tax rates as a function of market price (percent)

Tax Jurisdiction	Lower-Limit Prices				Upper-Limit Prices			
	High-Grade Unconformity Project	Quartz-Pebble Conglomerate Project	Conventional-Grade Unconformity Project	Uranium-Polymetallic Project	High-Grade Unconformity Project	Quartz-Pebble Conglomerate Project	Conventional-Grade Unconformity Project	Uranium-Polymetallic Project
Canada								
Ontario	54	..	..	..	46	55	47	50
Northwest Territories	49	..	..	..	41	48	43	44
Saskatchewan								
New uranium royalty	65	..	..	..	73	77	74	72
Old uranium royalty	65	..	..	..	76	66	72	72
Metallic minerals royalty	59	..	..	..	47	57	50	50
Australia								
Northern Territory	68	..	..	..	48	63	53	53
Queensland	60	..	..	..	46	57	50	49
South Australia								
General royalty	59	..	..	..	44	56	49	48
Olympic Dam royalty	62	..	..	..	49	60	53	52
Western Australia	62	..	..	..	46	60	51	50

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Table 33. Effective tax rates as a function of the cost of capital (percent)

Tax Jurisdiction	5-percent Cost of Capital				15-percent Cost of Capital			
	High-Grade Unconformity Project	Quartz-Pebble Conglomerate Project	Conventional-Grade Unconformity Project	Uranium-Polymetallic Project	High-Grade Unconformity Project	Quartz-Pebble Conglomerate Project	Conventional-Grade Unconformity Project	Uranium-Polymetallic Project
Canada								
Ontario	46	57	48	51	50	..	62	86
Northwest Territories	41	47	43	43	46	..	58	77
Saskatchewan								
New uranium royalty	65	63	64	59	72	..	84	..
Old uranium royalty	68	57	61	60	74	..	80	100
Metallic minerals royalty	46	58	51	50	53	..	70	94
Australia								
Northern Territory	49	69	57	56	58	..	81	..
Queensland	46	58	51	48	53	..	73	96
South Australia								
General royalty	44	58	50	48	52	..	72	96
Olympic Dam royalty	49	62	54	52	57	..	76	..
Western Australia	47	63	53	51	55	..	76	..

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Table 34. Effective tax rates by component for high-grade unconformity project under base case conditions (percent)

Tax Jurisdiction	Level of Government		Type of Payment	
	Federal and Commonwealth	Provincial Territorial, and State	Income Tax	Mining Tax and Royalty
Canada				
Ontario	23	25	35	13
Northwest Territories	23	20	32	11
Saskatchewan				
New uranium royalty	23	45	35	33
Old uranium royalty	23	47	35	35
Metallic minerals royalt	23	26	35	14
Australia				
Northern Territory	40	12	40	12
Queensland	43	6	43	6
South Australia				
General royalty	44	4	44	4
Olympic Dam royalty	41	11	41	11
Western Australia	42	8	42	8

Table 35. Effective tax rates by component for quartz-pebble conglomerate project under base case conditions (percent)

Tax Jurisdiction	Level of Government		Type of Payment	
	Federal and Commonwealth	Provincial Territorial, and State	Income Tax	Mining Tax and Royalty
Canada				
Ontario	47	52	70	29
Northwest Territories	46	36	63	19
Saskatchewan				
New uranium royalty	..	..	..	..
Old uranium royalty	..	..	..	..
Metallic minerals royalt	..	..	..	..
Australia				
Northern Territory	..	..	..	..
Queensland	..	..	..	..
South Australia				
General royalty	..	..	..	..
Olympic Dam royalty	..	..	..	..
Western Australia	..	..	..	..

.. uneconomic situation

Table 36. Effect tax rates by component for conventional-grade unconformity project under base case conditions (percent)

Tax Jurisdiction	Level of Government		Type of Payment	
	Federal and Commonwealth	Provincial Territorial, and State	Income Tax	Mining Tax and Royalty
Canada				
Ontario	27	26	40	13
Northwest Territories	27	22	36	13
Saskatchewan				
New uranium royalty	27	44	40	31
Old uranium royalty	27	41	41	27
Metallic minerals royalty	27	31	40	18
Australia				
Northern Territory	48	18	48	18
Queensland	52	7	52	7
South Australia				
General royalty	52	6	52	6
Olympic Dam royalty	51	11	51	11
Western Australia	51	11	51	11

Table 37. Effective tax rates by component for uranium-polymetallic project under base case conditions (percent)

Tax Jurisdiction	Level of Government		Type of Payment	
	Federal and Commonwealth	Provincial Territorial, and State	Income Tax	Mining Tax and Royalty
Canada				
Ontario	28	31	42	17
Northwest Territories	28	23	37	14
Saskatchewan				
New uranium royalty	28	41	42	27
Old uranium royalty	28	41	42	27
Metallic minerals royalty	28	33	42	19
Australia				
Northern Territory	47	23	47	23
Queensland	54	7	54	7
South Australia				
General royalty	54	7	54	7
Olympic Dam royalty	51	13	51	13
Western Australia	52	12	52	12

Table 38. Effective tax rates by component for high-grade unconformity project as a function of market price (percent)

Tax Jurisdiction	Lower-Limit Prices				Upper-Limit Prices			
	Level of Government		Type of Payment		Level of Government		Type of Payment	
	Federal, Commonwealth	Provincial Territorial, and State	Income Tax	Mining Tax and Royalty	Federal, Commonwealth	Provincial Territorial, and State	Income Tax	Mining Tax and Royalty
Canada								
Ontario	26	28	39	15	23	23	34	12
Northwest Territories	26	23	36	13	23	18	30	11
Saskatchewan								
New uranium royalty	26	39	40	25	23	50	34	39
Old uranium royalty	26	39	40	25	23	53	34	42
Metallic minerals royalty	26	33	40	19	23	24	34	13
Australia								
Northern Territory	47	21	47	21	39	9	39	9
Queensland	53	7	53	7	41	5	41	5
South Australia								
General royalty	53	6	53	6	41	3	41	3
Olympic Dam royalty	51	11	51	11	38	11	38	11
Western Australia	51	11	51	11	40	6	40	6

Table 39. Effect tax rates by component for quartz-pebble conglomerate project as a function of market price (percent)

Tax Jurisdiction	Lower-Limit Prices				Upper-Limit Prices			
	Level of Government		Type of Payment		Level of Government		Type of Payment	
	Federal, Commonwealth	Provincial Territorial, and State	Income Tax	Mining Tax and Royalty	Federal, Commonwealth	Provincial Territorial, and State	Income Tax	Mining Tax and Royalty
Canada								
Ontario	..	..	..	..	26	29	39	16
Northwest Territories	..	..	..	..	26	22	35	13
Saskatchewan								
New uranium royalty	..	..	..	..	26	51	40	37
Old uranium royalty	..	..	..	..	26	40	40	26
Metallic minerals royalty	..	..	..	..	26	31	40	17
Australia								
Northern Territory	..	..	..	..	46	17	46	17
Queensland	..	..	..	..	50	7	50	7
South Australia								
General royalty	..	..	..	..	50	6	50	6
Olympic Dam royalty	..	..	..	..	48	12	48	12
Western Australia	..	..	..	..	49	11	49	11

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Table 40. Effective tax rates by component for conventional-grade unconformity project as a function of market price (percent)

Tax Jurisdiction	Lower-Limit Prices				Upper-Limit Prices			
	Level of Government		Type of Payment		Level of Government		Type of Payment	
	Federal, Commonwealth	Provincial Territorial, and State	Income Tax	Mining Tax and Royalty	Federal, Commonwealth	Provincial Territorial, and State	Income Tax	Mining Tax and Royalty
Canada								
Ontario	..	..	..	..	24	23	36	11
Northwest Territories	..	..	..	..	24	19	32	11
Saskatchewan								
New uranium royalty	..	..	..	..	24	50	36	38
Old uranium royalty	..	..	..	..	24	48	36	36
Metallic minerals royalty	..	..	..	..	24	26	36	14
Australia								
Northern Territory	..	..	..	..	42	11	42	11
Queensland	..	..	..	..	44	6	44	6
South Australia								
General royalty	..	..	..	..	45	4	45	4
Olympic Dam royalty	..	..	..	..	42	11	42	11
Western Australia	..	..	..	..	43	8	43	8

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Table 41. Effective tax rates by component for uranium–polymetallic project as a function of market price (percent)

Tax Jurisdiction	Lower-Limit Prices				Upper-Limit Prices			
	Level of Government		Type of Payment		Level of Government		Type of Payment	
	Federal, Commonwealth	Provincial Territorial, and State	Income Tax	Mining Tax and Royalty	Federal, Commonwealth	Provincial Territorial, and State	Income Tax	Mining Tax and Royalty
Canada								
Ontario	..	..	..	..	24	26	36	14
Northwest Territories	..	..	..	..	24	20	32	12
Saskatchewan								
New uranium royalty	..	..	..	..	24	48	36	36
Old uranium royalty	..	..	..	..	24	48	36	36
Metallic minerals royalty	..	..	..	..	24	26	36	14
Australia								
Northern Territory	..	..	..	..	41	12	41	12
Queensland	..	..	..	..	43	6	43	6
South Australia								
General royalty	..	..	..	..	44	4	44	4
Olympic Dam royalty	..	..	..	..	41	11	41	11
Western Australia	..	..	..	..	43	7	43	7

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Appendix VIII

Intergovernmental Tax Shares

Table 42. Government tax shares for high-grade unconformity project under base case conditions (percent)

Tax Jurisdiction	Level of Government		Type of Payment	
	Federal and Commonwealth	Provincial Territorial, and State	Income Tax	Mining Tax and Royalty
Canada				
Ontario	49	51	74	26
Northwest Territories	55	45	74	26
Saskatchewan				
New uranium royalty	35	65	52	48
Old uranium royalty	33	67	50	50
Metallic minerals royalty	48	52	72	28
Australia				
Northern Territory	78	22	69	31
Queensland	88	12	88	12
South Australia				
General royalty	92	8	92	8
Olympic Dam royalty	79	21	79	21
Western Australia	85	15	85	15

Table 43. Government tax shares for quartz-pebble conglomerate project under base case conditions (percent)

Tax Jurisdiction	Level of Government		Type of Payment	
	Federal and Commonwealth	Provincial Territorial, and State	Income Tax	Mining Tax and Royalty
Canada				
Ontario	47	53	71	29
Northwest Territories	57	43	76	24
Saskatchewan				
New uranium royalty	..	..	..	..
Old uranium royalty	..	..	..	..
Metallic minerals royalty	..	..	..	..
Australia				
Northern Territory	..	..	..	..
Queensland	..	..	..	..
South Australia				
General royalty	..	..	..	..
Olympic Dam royalty	..	..	..	..
Western Australia	..	..	..	..

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Table 44. Government tax shares for conventional-grade unconformity project under base case conditions (percent)

Tax Jurisdiction	Level of Government		Type of Payment	
	Federal and Commonwealth	Provincial Territorial, and State	Income Tax	Mining Tax and Royalty
Canada				
Ontario	50	50	76	24
Northwest Territories	55	45	74	26
Saskatchewan				
New uranium royalty	37	63	57	43
Old uranium royalty	39	61	60	40
Metallic minerals royalty	46	54	69	31
Australia				
Northern Territory	73	27	73	27
Queensland	88	12	88	12
South Australia				
General royalty	90	10	90	10
Olympic Dam royalty	82	18	82	18
Western Australia	82	18	82	18

Table 45. Government tax shares for uranium-polymetallic project under base case conditions (percent)

Tax Jurisdiction	Level of Government		Type of Payment	
	Federal and Commonwealth	Provincial Territorial, and State	Income Tax	Mining Tax and Royalty
Canada				
Ontario	47	53	70	30
Northwest Territories	54	43	73	27
Saskatchewan				
New uranium royalty	40	60	61	39
Old uranium royalty	40	60	61	39
Metallic minerals royalty	46	54	70	30
Australia				
Northern Territory	67	33	67	33
Queensland	88	12	88	12
South Australia				
General royalty	88	12	88	12
Olympic Dam royalty	79	21	79	21
Western Australia	81	19	81	19

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Table 46. Government tax shares for high-grade unconformity project as a function of market price (percent)

Tax Jurisdiction	Lower-Limit Prices				Upper-Limit Prices			
	Level of Government		Type of Payment		Level of Government		Type of Payment	
	Federal, Commonwealth	Provincial Territorial, and State	Income Tax	Mining Tax and Royalty	Federal, Commonwealth	Provincial Territorial, and State	Income Tax	Mining Tax and Royalty
Canada								
Ontario	49	51	73	27	49	51	74	26
Northwest Territories	54	46	73	27	55	45	74	26
Saskatchewan								
New uranium royalty	41	59	62	38	31	69	47	53
Old uranium royalty	41	59	62	38	30	70	45	55
Metallic minerals royalty	45	55	69	31	49	51	74	26
Australia								
Northern Territory	69	31	69	31	81	19	81	19
Queensland	88	12	88	12	88	12	88	12
South Australia								
General royalty	90	10	90	10	93	7	93	7
Olympic Dam royalty	82	18	82	18	78	22	78	22
Western Australia	81	19	81	19	86	14	86	14

Table 47. Government tax shares for quartz-pebble conglomerate project as a function of market price (percent)

Tax Jurisdiction	Lower-Limit Prices				Upper-Limit Prices			
	Level of Government		Type of Payment		Level of Government		Type of Payment	
	Federal, Commonwealth	Provincial Territorial, and State	Income Tax	Mining Tax and Royalty	Federal, Commonwealth	Provincial Territorial, and State	Income Tax	Mining Tax and Royalty
Canada								
Ontario	..	..	..	..	47	53	71	29
Northwest Territories	..	..	..	..	55	45	74	26
Saskatchewan								
New uranium royalty	..	..	..	..	34	66	52	48
Old uranium royalty	..	..	..	..	40	60	60	40
Metallic minerals royalty	..	..	..	..	46	54	70	30
Australia								
Northern Territory	..	..	..	..	74	26	74	26
Queensland	..	..	..	..	88	12	88	12
South Australia								
General royalty	..	..	..	..	90	10	90	10
Olympic Dam royalty	..	..	..	..	81	19	81	19
Western Australia	..	..	..	..	81	19	81	19

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Table 48. Government tax shares for conventional-grade unconformity project as a function of market price (percent)

Tax Jurisdiction	Lower-Limit Prices				Upper-Limit Prices			
	Level of Government		Type of Payment		Level of Government		Type of Payment	
	Federal, Commonwealth	Provincial Territorial, and State	Income Tax	Mining Tax and Royalty	Federal, Commonwealth	Provincial Territorial, and State	Income Tax	Mining Tax and Royalty
Canada								
Ontario	..	..	..	..	51	49	76	24
Northwest Territories	..	..	..	..	55	45	74	26
Saskatchewan								
New uranium royalty	..	..	..	..	32	68	49	51
Old uranium royalty	..	..	..	..	33	67	50	50
Metallic minerals royalty	..	..	..	..	48	52	72	28
Australia								
Northern Territory	..	..	..	..	78	22	78	22
Queensland	..	..	..	..	88	12	88	12
South Australia								
General royalty	..	..	..	..	92	8	92	8
Olympic Dam royalty	..	..	..	..	79	21	79	21
Western Australia	..	..	..	..	85	15	85	15

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Table 49. Government tax shares for uranium-polymetallic project as a function of market price (percent)

Tax Jurisdiction	Lower-Limit Prices				Upper-Limit Prices			
	Level of Government		Type of Payment		Level of Government		Type of Payment	
	Federal, Commonwealth	Provincial Territorial, and State	Income Tax	Mining Tax and Royalty	Federal, Commonwealth	Provincial Territorial, and State	Income Tax	Mining Tax and Royalty
Canada								
Ontario	..	..	..	..	47	53	70	30
Northwest Territories	..	..	..	..	55	45	74	26
Saskatchewan								
New uranium royalty	..	..	..	..	33	67	50	50
Old uranium royalty	..	..	..	..	33	67	50	50
Metallic minerals royalty	..	..	..	..	48	52	73	27
Australia								
Northern Territory	..	..	..	..	76	24	76	24
Queensland	..	..	..	..	88	12	88	12
South Australia								
General royalty	..	..	..	..	91	9	91	9
Olympic Dam royalty	..	..	..	..	78	22	78	22
Western Australia	..	..	..	..	85	15	85	15

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Appendix IX

Comparative Levels of Taxation

Table 50. Comparative tax levels under base case conditions

Tax Jurisdiction	Uranium Project			
	High-Grade Unconformity	Quartz-Pebble Conglomerate	Conventional-Grade Unconformity	Uranium-Polymetallic
Canada				
Ontario	71	87	74	85
Northwest Territories	63	72	68	74
Saskatchewan				
New uranium royalty	100	..	100	100
Old uranium royalty	104	..	95	99
Metallic minerals royalt	73	..	82	87
Australia				
Northern Territory	78	..	92	101
Queensland	72	..	83	87
South Australia				
General royalty	70	..	82	87
Olympic Dam royalty	77	..	86	93
Western Australia	74	..	87	92

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Note: Index = 100 for Saskatchewan's new uranium royalty system.

Table 51. Comparative tax levels as a function of market price

Tax Jurisdiction	Lower-Limit Prices				Upper-Limit Prices			
	High-Grade Unconformity Project	Quartz-Pebble Conglomerate Project	Conventional-Grade Unconformity Project	Uranium-Polymetallic Project	High-Grade Unconformity Project	Quartz-Pebble Conglomerate Project	Conventional-Grade Unconformity Project	Uranium-Polymetallic Project
Canada								
Ontario	84	..	..	..	63	72	64	69
Northwest Territories	76	..	..	..	56	62	58	60
Saskatchewan								
New uranium royalty	100	..	..	..	100	100	100	100
Old uranium royalty	100	..	..	..	103	86	97	99
Metallic minerals royalty	91	..	..	..	64	74	68	69
Australia								
Northern Territory	105	..	..	..	66	82	72	74
Queensland	92	..	..	..	62	74	67	68
South Australia								
General royalty	91	..	..	..	61	73	65	67
Olympic Dam royalty	96				67	78	71	73
Western Australia	97	..	..	..	63	78	69	69

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Note: Index = 100 for Saskatchewan's new uranium royalty system.

Table 52. Comparative tax levels as a function of the cost of capital

Tax Jurisdiction	5-percent Cost of Capital				15-percent Cost of Capital			
	High-Grade Unconformity Project	Quartz-Pebble Conglomerate Project	Conventional-Grade Unconformity Project	Uranium Polymetallic Project	High-Grade Unconformity Project	Quartz-Pebble Conglomerate Project	Conventional-Grade Unconformity Project	Uranium Polymetallic Project
Canada								
Ontario	72	91	75	87	70	..	74	84
Northwest Territories	63	74	67	73	64	..	69	75
Saskatchewan								
New uranium royalty	100	100	100	100	100	..	100	..
Old uranium royalty	105	91	95	103	104	..	94	96
Metallic minerals royalty	71	92	80	84	84	..	83	91
Australia								
Northern Territory	75	109	88	95	80	..	96	..
Queensland	70	92	80	83	74	..	86	93
South Australia								
General royalty	68	92	79	82	73	..	85	93
Olympic Dam royalty	75	98	83	88	79	..	90	..
Western Australia	72	100	83	86	76	..	90	..

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Note: Index = 100 for Saskatchewan's new uranium royalty system.

Table 53. Comparative tax levels by component for high-grade unconformity project under base case conditions

Tax Jurisdiction	Level of Government		Type of Payment	
	Federal and Commonwealth	Provincial Territorial, and State	Income Tax	Mining Tax and Royalty
Canada				
Ontario	100	55	99	39
Northwest Territories	100	44	89	35
Saskatchewan				
New uranium royalty	100	100	100	100
Old uranium royalty	100	107	100	109
Metallic minerals royalty	100	58	100	42
Australia				
Northern Territory	174	27	115	37
Queensland	184	13	121	18
South Australia				
General royalty	187	9	123	12
Olympic Dam royalty	176	25	116	34
Western Australia	181	17	119	24

Table 54. Comparative tax levels by component for quartz-pebble conglomerate project under base case conditions

Tax Jurisdiction	Level of Government		Type of Payment	
	Federal and Commonwealth	Provincial Territorial, and State	Income Tax	Mining Tax and Royalty
Canada				
Ontario	100	78	99	68
Northwest Territories	100	53	89	45
Saskatchewan				
New uranium royalty	..	..	..	..
Old uranium royalty	..	..	..	..
Metallic minerals royalty	..	..	..	..
Australia				
Northern Territory	..	..	..	..
Queensland	..	..	..	..
South Australia				
General royalty	..	..	..	..
Olympic Dam royalty	..	..	..	..
Western Australia	..	..	..	..

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Note: Index = 100 for Saskatchewan's new uranium royalty system.

Table 55. Comparative tax levels by component for conventional-grade unconformity project under base case conditions

Tax Jurisdiction	Level of Government		Type of Payment	
	Federal and Commonwealth	Provincial Territorial, and State	Income Tax	Mining Tax and Royalty
Canada				
Ontario	100	59	99	42
Northwest Territories	100	49	89	41
Saskatchewan				
New uranium royalty	100	100	100	100
Old uranium royalty	100	92	100	88
Metallic minerals royalty	100	71	100	58
Australia				
Northern Territory	180	40	118	57
Queensland	196	16	129	23
South Australia				
General royalty	198	13	130	18
Olympic Dam royalty	190	25	125	36
Western Australia	189	25	125	37

Table 56. Comparative tax levels by component for uranium-polymetallic project under base case conditions

Tax Jurisdiction	Level of Government		Type of Payment	
	Federal and Commonwealth	Provincial Territorial, and State	Income Tax	Mining Tax and Royalty
Canada				
Ontario	100	76	99	65
Northwest Territories	100	56	89	50
Saskatchewan				
New uranium royalty	100	100	100	100
Old uranium royalty	100	99	100	98
Metallic minerals royalty	100	79	100	68
Australia				
Northern Territory	170	55	112	85
Queensland	192	18	126	27
South Australia				
General royalty	192	18	126	27
Olympic Dam royalty	184	32	121	48
Western Australia	185	30	122	46

Note: Index = 100 for Saskatchewan's new uranium royalty system.

Table 57. Comparative tax levels by component for high-grade unconformity project as a function of market price

Tax Jurisdiction	Lower-Limit Prices				Upper-Limit Prices			
	Level of Government		Type of Payment		Level of Government		Type of Payment	
	Federal, Commonwealth	Provincial Territorial, and State	Income Tax	Mining Tax and Royalty	Federal, Commonwealth	Provincial Territorial, and State	Income Tax	Mining Tax and Royalty
Canada								
Ontario	100	73	99	60	100	46	99	31
Northwest Territories	100	59	89	54	100	37	89	28
Saskatchewan								
New uranium royalty	100	100	100	100	100	100	100	100
Old uranium royalty	100	101	100	101	100	105	100	106
Metallic minerals royalty	100	85	100	76	100	47	100	32
Australia								
Northern Territory	178	54	117	85	172	18	113	24
Queensland	198	19	130	30	179	11	118	14
South Australia								
General royalty	200	15	131	24	183	6	120	8
Olympic Dam royalty	192	29	127	45	169	21	111	28
Western Australia	191	31	126	48	177	13	116	16

Note: Index = 100 for Saskatchewan's new uranium royalty system.

Table 58. Comparative tax levels by component for quartz-pebble conglomerate project as a function of market price

Tax Jurisdiction	Lower-Limit Prices				Upper-Limit Prices			
	Level of Government		Type of Payment		Level of Government		Type of Payment	
	Federal, Commonwealth	Provincial Territorial, and State	Income Tax	Mining Tax and Royalty	Federal, Commonwealth	Provincial Territorial, and State	Income Tax	Mining Tax and Royalty
Canada								
Ontario	..	..	..	..	100	58	99	44
Northwest Territories	..	..	..	..	100	43	89	34
Saskatchewan								
New uranium royalty	..	..	..	..	100	100	100	100
Old uranium royalty	..	..	..	..	100	79	100	71
Metallic minerals royalty	..	..	..	..	100	60	100	46
Australia								
Northern Territory	..	..	..	..	177	33	117	44
Queensland	..	..	..	..	192	14	126	18
South Australia								
General royalty	..	..	..	..	194	11	127	15
Olympic Dam royalty	..	..	..	..	185	23	122	31
Western Australia	..	..	..	..	185	22	122	31

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Note: Index = 100 for Saskatchewan's new uranium royalty system.

Table 59. Comparative tax levels by component for conventional-grade unconformity project as a function of market price

Tax Jurisdiction	Lower-Limit Prices				Upper-Limit Prices			
	Level of Government		Type of Payment		Level of Government		Type of Payment	
	Federal, Commonwealth	Provincial Territorial, and State	Income Tax	Mining Tax and Royalty	Federal, Commonwealth	Provincial Territorial, and State	Income Tax	Mining Tax and Royalty
Canada								
Ontario	..	..	..	..	100	46	99	30
Northwest Territories	..	..	..	..	100	39	89	30
Saskatchewan								
New uranium royalty	..	..	..	..	100	100	100	100
Old uranium royalty	..	..	..	..	100	95	100	94
Metallic minerals royalty	..	..	..	..	100	52	100	37
Australia								
Northern Territory	..	..	..	..	175	23	115	30
Queensland	..	..	..	..	184	12	121	16
South Australia								
General royalty	..	..	..	..	187	8	123	10
Olympic Dam royalty	..	..	..	..	176	22	116	29
Western Australia	..	..	..	..	181	16	119	21

.. uneconomic situation

Note: Index = 100 for Saskatchewan's new uranium royalty system.

Table 60. Comparative tax levels by component for uranium–polymetallic project as a function of market price

Tax Jurisdiction	Lower-Limit Prices				Upper-Limit Prices			
	Level of Government		Type of Payment		Level of Government		Type of Payment	
	Federal, Commonwealth	Provincial Territorial, and State	Income Tax	Mining Tax and Royalty	Federal, Commonwealth	Provincial Territorial, and State	Income Tax	Mining Tax and Royalty
Canada								
Ontario	..	..	..	..	100	54	99	40
Northwest Territories	..	..	..	..	100	41	89	32
Saskatchewan								
New uranium royalty	..	..	..	..	100	100	100	100
Old uranium royalty	..	..	..	..	100	99	100	98
Metallic minerals royalty	..	..	..	..	100	53	100	37
Australia								
Northern Territory	..	..	..	..	171	26	112	35
Queensland	..	..	..	..	182	12	120	16
South Australia								
General royalty	..	..	..	..	185	9	121	12
Olympic Dam royalty	..	..	..	..	173	24	114	32
Western Australia	..	..	..	..	180	15	118	20

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Note: Index = 100 for Saskatchewan's new uranium royalty system.

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